Sky and TELESCOPE

Swain

Moonrise at Flagstaff

In This Issue:

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Vol. XVI, No. 1
NOVEMBER, 1956
50 cents
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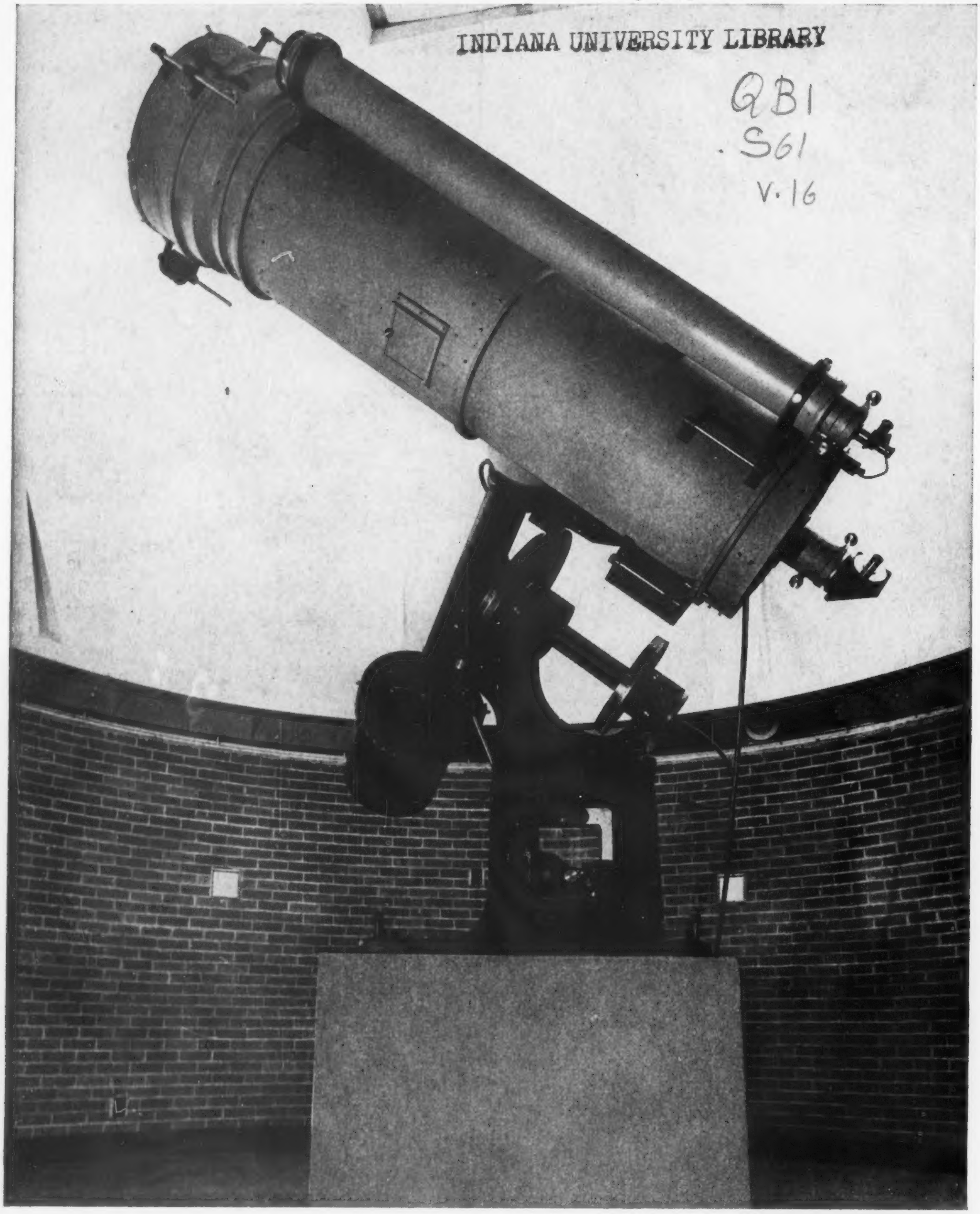
M.
Swain



Sky and TELESCOPE

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Vol. XVI, No. 1 NOVEMBER, 1956

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The principal articles are indexed in THE READERS' GUIDE TO PERIODICAL LITERATURE.

Color Lantern Slides from Palomar Observatory

THE CONTINUING NEED of amateur astronomers and the general public for pictures and lantern slides of astronomical observatories and celestial objects has long been filled by the photographic departments at the following institutions in the United States:

Lick Observatory, Mt. Hamilton, Calif.

Yerkes Observatory, Williams Bay, Wisc.

Mount Wilson and Palomar Observatories, through the California Institute of Technology Bookstore, 1201 E. California St., Pasadena 4, Calif.

Catalogues may be obtained from each of these sources, those from Yerkes and Caltech containing miniature reproductions of many of their subjects. Photographic prints, film strips, and lantern slides in two sizes are available in most cases, and Caltech sells 16-by-20-inch prints of 200-inch photographs at $6.00 plus packing. The bookstore states that a number of new pictures taken with the 200-inch, 100-inch, and 48-inch telescopes not listed in the Mount Wilson and Palomar catalogue are now available.

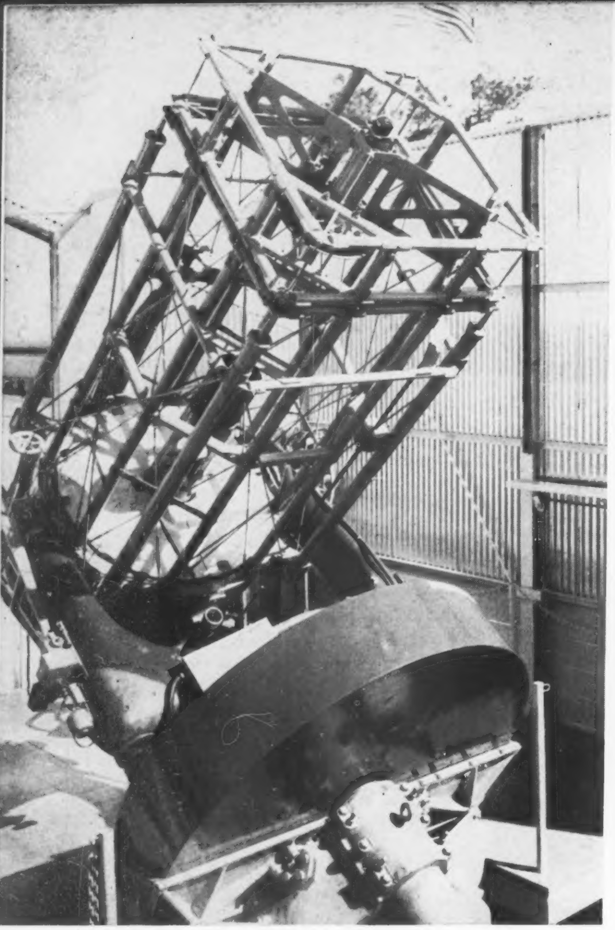
Also, a set of 18 color slides (35-mm.) of Palomar Observatory is ready for distribution, the first such pictures to show the 200-inch and 48-inch in operation. Nos. 1 to 15 concern the former, Nos. 16 to 18 the latter telescope:

1. Winter scene, 200-inch dome shutters closed. 2. Hale telescope and dome by moonlight. 3. 200-inch telescope. 4. 200-inch with astronomer in elevating chair. 5. Mirror cell, with astronomer at Cassegrainian focus. 6. Closeup of mirror cell. 7. Upper end of telescope, astronomer on elevator. 8. Dusk inside the dome, astronomer on elevator. 9. Astronomer getting into observer's cage. 10. Top of telescope, with astronomer in cage. 11. View inside prime-focus cage. 12. Astronomer at coude eyepiece. 13. Interior of coude room. 14. Interior of coude grating spectrograph. 15. Coude spectrograph. 16. 48-inch Schmidt telescope. 17. Assistant loading plateholder. 18. Detail of plateholder and loading mechanism.

The complete set of 18 slides costs $8.50; a set of 12 (1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 16) is $5.75; a set of six (1, 2, 3, 5, 7, 10) is $2.95. Individual slides are 75 cents each. The material is sent postpaid if payment is sent with the order.

CAPTION CORRECTION

The caption under the picture at the upper right of page 533, October issue, should read: "Kenneth Smith's 8-inch reflector took second place for mechanical perfection."



The Flagstaff Station of the U. S. Naval Observatory

JOHN S. HALL and ARTHUR A. HOAG
United States Naval Observatory

The outer skeleton tube of the 40-inch reflector is square, and it contains counterpoises to neutralize flexure. The octagonal framework carries the secondary mirror, which is focused by a motor drive. The primary mirror, at the lower end of the tube, is covered in this picture; extending upward from its center is a cylindrical light baffle.

THE MAJOR light-gathering instrument of the U. S. Naval Observatory is its 40-inch Ritchey-Chrétien telescope, which had been in operation at Washington since 1934. But as the nation's capital grew, increasing city lights and smoke reduced the effectiveness of this instrument. Through the efforts of the senior author and Captain F. A. Graf, superintendent of the observatory from 1951 to 1956, money was appropriated in 1954 for the transfer of the telescope to a more suitable location.

After a study of meteorological factors, and consideration of records from existing observatories, a site-test survey was carried out in the vicinity of Flagstaff, Arizona. A two-man team visited this area in 1951 and made visual observational checks. The results of these tests and other factors, such as accessibility, finally led to the choice of a hilltop about five miles west of Flagstaff.

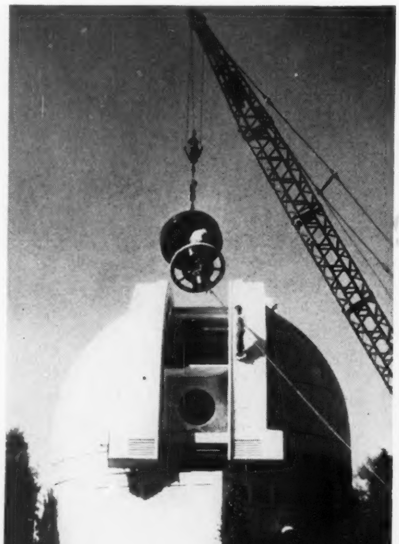
This new observatory site is 7,600 feet above sea level. It is easy to reach, being only one mile south of U. S. Route 66, on a new graded road. The excellence of the atmospheric conditions here is well shown by the cover photograph of the moon rising over Mt. Elden, nine miles away. Staff members at the new station are not scientifically isolated, for Lowell Observatory and the Atmospheric Research Observatory of Arizona State College are close at hand.

The telescope shelter at the Flagstaff station is drastically different from the conventional dome that housed the reflector when it was in Washington. The roof of the new building rolls off on tracks to the north, thus permitting rapid setting of the telescope from one part of the sky to another. The observer enjoys a majestic view of the heavens that more than compensates for the greater warmth of a dome.

In this type of building, buffeting of the telescope by the wind is a disadvantage that has been overcome by wind screens—movable panels on the interior walls of the observatory. These can be raised hydraulically by as much as nine feet, as shown in the photograph on the next page. In addition, winds from the north are blocked by the movable roof.

Another convenient feature of the building is a hydraulically-operated rising floor, which facilitates handling heavy equipment and greatly adds to the observers' comfort. For example, the rising floor enables a lone observer to remove a tailpiece fixture, such as the double-slide plateholder, and replace it with our 90-pound spectrograph in about five minutes. The rising floor also makes it easy to remove the cell and mirror for aluminizing. When it was at Washington, the 40-inch mirror had to be re-aluminized every two years, but it is expected that the mirror coating will last much longer in the dry, clean air of this part of Arizona.

Late in September, 1955, the telescope was removed from its former dome in a single day—a somewhat spectacular demonstration of the rigger's art. All of the equipment for the new installation was transported to Flagstaff on two trailer trucks. Thanks to the skill of the same riggers, and of George Gingras, George E. Steinacker, and Joseph P. Egan of the Naval Observatory staff, optical alignment of the instrument was begun only six days after the trucks arrived at the new site. We were pleasantly surprised when we first looked through the telescope at



At the Naval Observatory in Washington, riggers lift the polar-axis assembly out of the 40-inch telescope's original dome, in preparation for the move to Flagstaff. The perforated shield in the lower part of the slit was once used as a screen to keep stray light from entering the skeleton-tubed telescope.

A winter view of the Flagstaff station from the northeast. In the foreground is the service building with living quarters, machine shop, and offices. The telescope building is at the far left, and next to it are the elevated rails on which the roof runs off to the north.

familiar sky objects now glorified by the better observing conditions.

North of the telescope house there is a functional but well-equipped service building. The floors of both are on the same level, and a connecting walk makes it easy to move equipment from one building to the other.

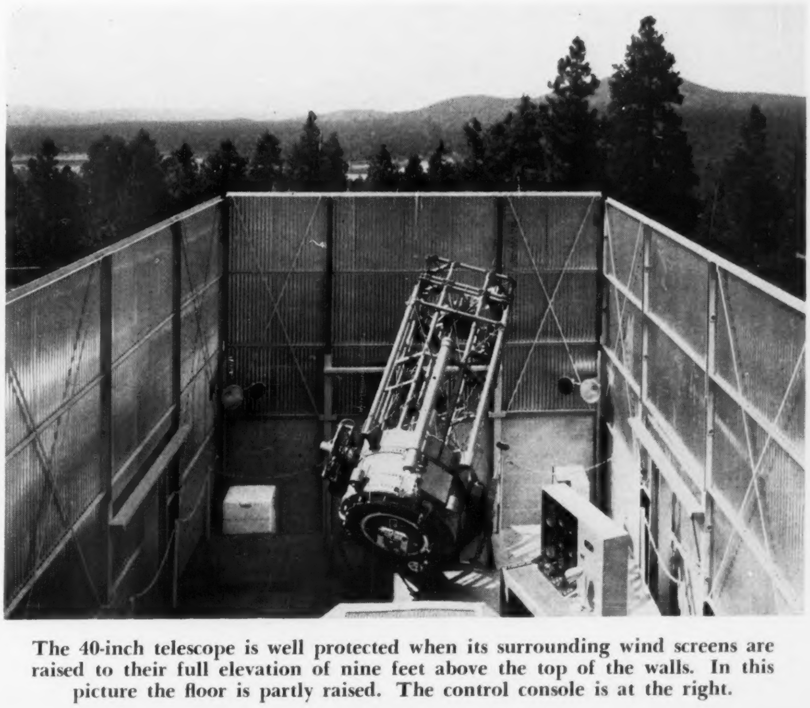
Just inside the south entrance of the service building is the "observer's aids" room. Here is a temperature-controlled cabinet for two local frequency standards, a radio for time signals, the recorder for the photoelectric Polaris monitor described later, and a kitchenette. A large part of the service building is taken up by the instrument-making shop, which is under the direction of Mr. Egan. Also under the same roof are a photographic darkroom, two offices, an instrument room, as well as a garage and storage space. In addition, there are living quarters for one person to accommodate any member of the Naval Observatory staff in Washington who goes to the station to work on observing programs.

The 40-inch itself is the last instrument built by the late George W. Ritchey, and is the largest telescope of the Ritchey-Chrétien design. He had previously constructed a 20-inch pilot model. The mounting of the 40-inch is of the fork type, closely resembling that of the 60-inch reflector at Mount Wilson Observatory, an instrument also built by Ritchey. A cylindrical float, located just below the base of the fork and concentric with the polar axle, rides in a mercury-filled trough, and effectively relieves the polar-axle bearings of the telescope load.

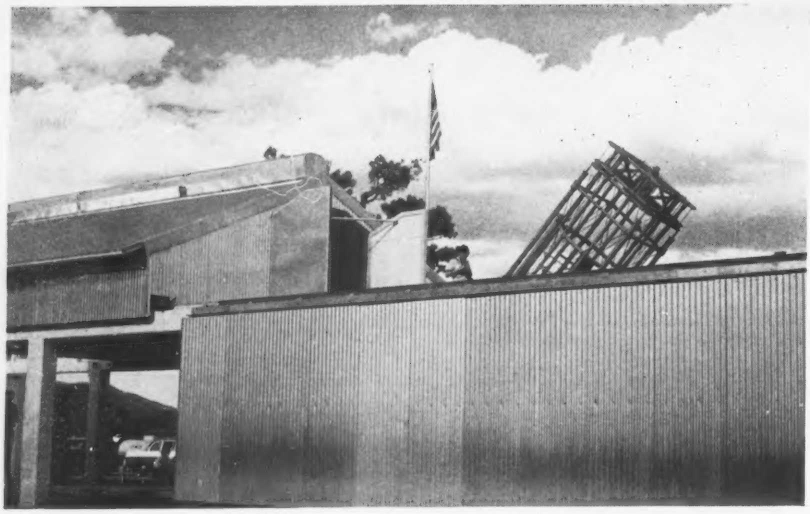
The optical design of the telescope, conceived by Henri Chrétien, is akin to the Cassegrainian form. However, it does not have the latter's paraboloidal primary mirror and hyperboloidal secondary; instead, the cross sections of the two mirrors' surfaces are modified conic sections. The f/4 primary mirror has a central hole nine inches in diameter. Behind this is the focal surface which, though curved, is free from spherical aberration and coma. In contrast to the restricted field of a conventional Cassegrainian, the Ritchey-Chrétien design gives good images on curved plates over a field 1½ degrees in diameter.

The relatively large 16-inch-diameter secondary mirror is only 96 inches distant from the primary, so the tube is extremely short. The tube structure is counterpoised to prevent flexure, which in any event would be small with so compact a telescope. The octagonal support for the secondary is constructed of aircraft tubing. The upper part of this support rides on four counterpoises carried by outer tubes. The effective focal length of the telescope is 272 inches, corresponding to a focal ratio of f/6.8, and the scale is about 30 seconds of arc per millimeter at the focal surface.

A number of improvements in the operating parts of this telescope were made at the time of the move. Most of the work was done at the Naval Observatory instrument shop. All the drives of the telescope were modernized. The original governor-controlled weight drive was replaced by a synchronous motor and differential gear box, which provides for two setting speeds in addition to the sidereal rate. The motor of the diurnal drive



The 40-inch telescope is well protected when its surrounding wind screens are raised to their full elevation of nine feet above the top of the walls. In this picture the floor is partly raised. The control console is at the right.



Shutters at the south end of the roof must be opened before the roof can be rolled off to the north, as seen here. The masonry walls of the telescope building are shielded on three sides by air-spaced corrugated aluminum baffling, to minimize temperature changes. Photograph by C. A. Federer, Jr.

is geared to operate either from ordinary commercial power or from a local frequency standard which is normally adjusted to run on mean solar time.

The slewing drives, to turn the telescope from one part of the sky to another, are operated by d.c. motors with Variac speed controls. Special split-wound Variacs are used, so the direction of motion of the telescope depends on the direction in which the control knob is turned. The slewing rate for either right ascension or declination can be continuously varied from three degrees down to about five minutes of arc per second of time. Additional drives provide setting speeds of 10 minutes of arc in 15 seconds of time, and slow speeds of 1/60 this rate.

In another improvement, a large tailpiece has been substituted for the old support for observing accessories, which consisted of a platform focused by four geared screws. The new tailpiece is an integral part of the primary mirror cell, and can be rotated about the optical axis. A quick-locking device permits rapid changing of auxiliary equipment. Since the tailpiece is fixed with respect to the primary mirror, the telescope is focused by moving the secondary mirror with a motor.

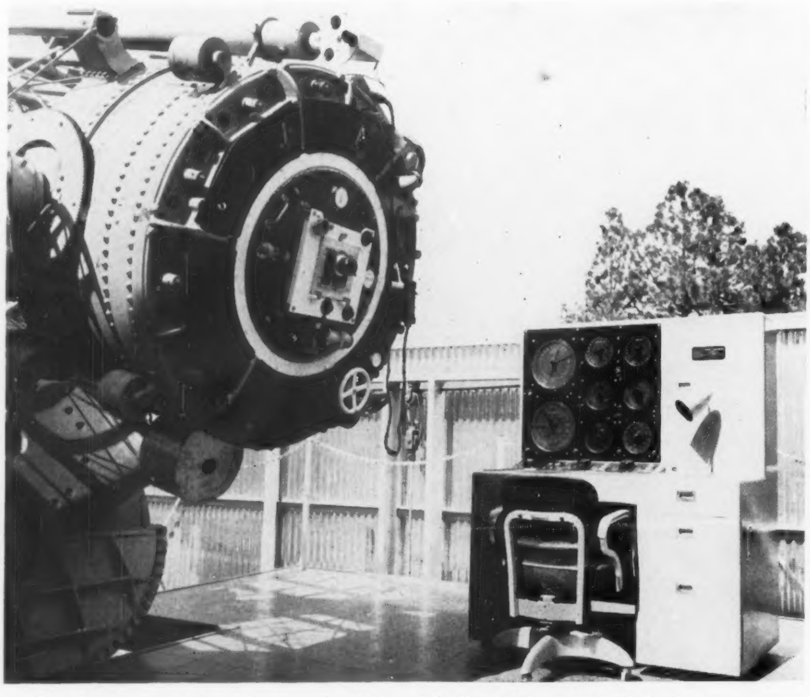
The most significant modernization of the 40-inch telescope is the control console, built for us by the Lombard Governor Corporation, Ashland, Mass. This allows a chairborne observer to operate the instrument and building, greatly increasing the ease and rapidity of handling the telescope. Two large dials on the left side of the console panel give the right ascension and declination toward which the telescope is pointing. (The right ascension is displayed directly, by means of a differential that automatically subtracts the hour angle of the telescope from the sidereal time.) Three smaller dials indicate the mean time, local sidereal time, and hour angle. The panel also indicates the focal setting of the telescope, and the air mass through which the instrument is looking. There are driving-rate indicators, and a timer for photographic exposures.

Directly below the display panel is a set of telescope motion controls. At the left of the console desk is another smaller panel, with switches for operating the roof, the rising floor, wind screens, and building lights. In case of emergency, the observer can punch a single button to deactivate all telescope and building circuits. The entire console is easily moved on its large rubber-wheeled casters to any convenient place on the observing floor, or removed from the building for servicing.

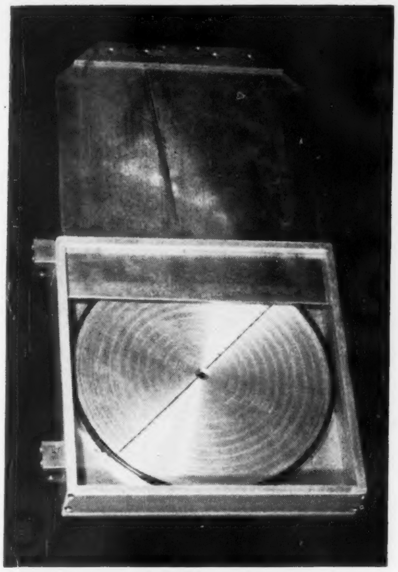
The brains of the console are the two vibrating-wire frequency standards in the service building, and their power amplifiers. These standards, developed by Henry E. Warren, president of the Lombard Governor Corp. and inventor of the Telechron clock, control the diurnal drive of the telescope and the console clocks. Similar frequency standards are in use at Palomar and Lick observatories. Their chief advantage is that the driving rate of the telescope is easily varied by remote control, in order to compensate for refraction effects, to widen spectra by trailing, or for other purposes.

Another vital part of the console equipment is the two Farrand Inductosyn systems which report the hour angle and declination settings of the telescope with an accuracy of better than five seconds of arc. The Inductosyn units may be roughly described as extremely accurate synchro devices that transmit the angular positions of the axes and provide, at the same time, a backlash-free electronic "gear increase" of 1 to 72.

In Washington, the mounting of the



An observer seated at the console at the right has full control of the instrument and building. The console gives complete indication of the telescope adjustments, the large dials displaying right ascension and declination. Between two banks of smaller dials is the counter that reports the focal setting of the 40-inch secondary mirror.



The plateholder for the 7-by-7-inch plates has a concave back, which was turned on a lathe. A vacuum pump withdraws air through the small central hole to suck the plate against this back, thus deforming it to match the curved focal surface of the Chretien telescope design.

telescope was supported by three pads set in the level upper surface of the pier. At Flagstaff, the top of the pier slopes down to the north at an angle of 3 degrees 43 minutes to compensate for the difference in latitude between the old and new sites. Only one structural change was made in the original mounting; we lengthened the fork arms nine inches to give more working room behind the mirror cell while observing at northerly declinations and to extend the southern declination limit of the telescope from $-33°$ to $-41°$.

A further improvement to the telescope is the addition of a sky-light baffle of the "stovepipe" variety. This shields the focal surface from light not coming through the optics of the telescope.

The observing programs of the 40-inch telescope include both photography and photoelectric photometry. One of the new tailpiece attachments is a double-slide carriage designed to hold a photographic back or photometers. The carriage may be shifted either manually or by motors, and sensitive dial indicators keep track of its position.

The photographic back that fits in this carriage contains a filter slide, a guiding prism system, plateholder supports, and a rotating calcite assembly (for photographic observations of the polarization of starlight). With the prism system, the observer can select a guide star from any point in the field, without having to shift the guiding eyepiece. So far we have used two plateholders. One is for 4-by-5-inch flat plates; the other takes 7-by-7-inch plates, curving them against a vacuum back to a 65-inch radius for best fit to the focal surface.

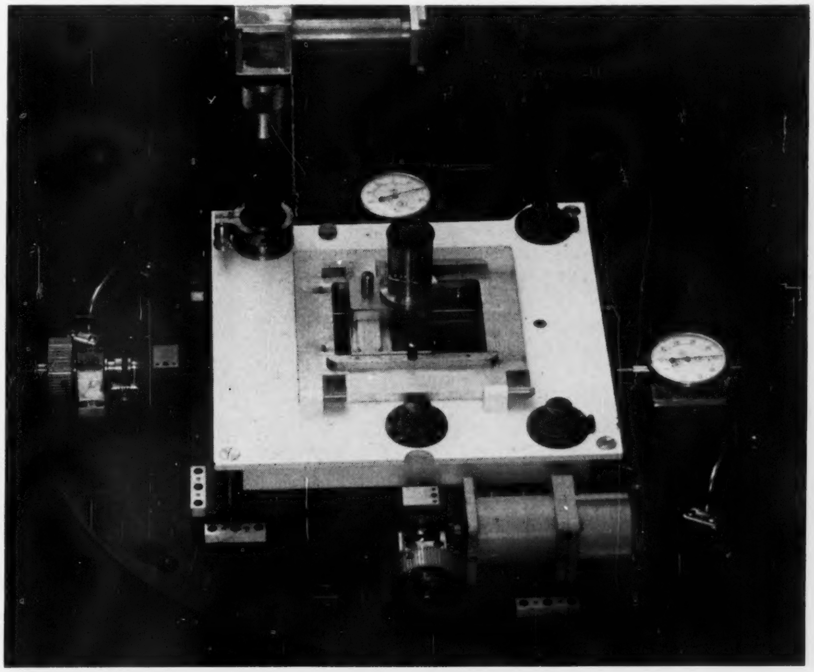
Three photoelectric photometers are available. One is a conventional d.c. photometer. A second is an a.c. colorimeter which allows star magnitudes and colors to be measured simultaneously. The third is an a.c. polarimeter for measuring the polarization of starlight; it is equipped with a programmer that guides this photometer automatically through a fairly complicated observing cycle. We are now assembling additional apparatus that will automatically punch the data directly onto IBM cards as the observations are being made. This will permit all data handling to be done by high-speed computing machines, and a larger part of our time may then be spent in obtaining new observations.

A plane-grating spectrograph completes the battery of attachments currently used with the 40-inch telescope. This has a collimator aperture of two inches, and uses an f/2 camera. The grating is a blazed Bausch and Lomb replica, having 300 lines per millimeter. With this equipment we photograph spectra at a dispersion of 200 angstroms per millimeter in the first order in infrared light (7000 to 9000 angstroms), and at a dispersion of 100 angstroms per millimeter for blue light in the second order. In a reasonable exposure time, we can obtain usable spectra in the blue for stars as faint as magnitude 14.

At the Flagstaff station, observing conditions are recorded by a Polaris monitor

This is the shelter that houses the Polaris monitor. This fully automatic instrument maintains a continuous record of sky transparency and brightness each night, and of the scintillation of the star Polaris.

—a small telescope fitted with a photoelectric receiver which is driven to follow Polaris continuously. Its operation is automatic; the receiver is programmed to observe Polaris, a comparison source within the instrument, and a blank patch of sky near Polaris, all in a continually repeated cycle. These observations are re-



This tailpiece attachment contains a double-slide carriage to which plateholders or photoelectric equipment can be fitted. Sensitive dial gauges indicate the position of the carriage, which can be moved by hand or motor. At the top is the prismatic guiding system. The four slotted holes are for locking the attachment to the tailpiece of the telescope, as seen in the picture opposite.

These preliminary test photographs indicate the effectiveness of the 40-inch Ritchey-Chretien telescope in its new location. At the left is a picture of M51, the great Whirlpool galaxy in Canes Venatici, taken on May 7, 1956. The spiral arms are broken up into starclouds, on which dark lanes and flecks of absorbing material are superimposed. At the right, even the faint outer portions of M27, the Dumbbell nebula in Vulpecula, are revealed in a 30-minute exposure made on September 3, 1956. The intricate structure of this planetary nebula indicates chaotic motions in the great gas cloud, which is illuminated by the faint, very hot star at its center. To retain the detail in the overexposed central region of the nebula, photographic dodging techniques were used in making the print. Although the scales of the two pictures are similar, note the much richer stellar background in which the Dumbbell nebula appears; M51, on the other hand, is seen through a relatively thin stratum of stars.

ported to a recorder in the service building. Here is displayed a continuous record of the transparency and brightness of the sky in the direction of the pole, as well as the scintillation of Polaris at two different frequencies. The monitor is turned on after dark and is stopped before dawn by a control timer. It needs no attention, except to change the recorder chart once a month, and to replenish the ink supply occasionally!

The clear, cool, dry climate at Flagstaff leaves little for the astronomer to desire. However, summer thunderstorms make July and August less satisfactory than other months for observing. The day-to-night temperature range is large—as is to be expected at high elevations—but on still nights this is moderated by good air drainage at our site. It is not uncommon for us to have nighttime temperatures 15 degrees above those recorded in the town of Flagstaff, which lies some 600 feet lower. Clear nights are three times as frequent and are much more transparent than those in Washington. But most impressive of all is the darkness of the sky at the Flagstaff station—only 1/15 as bright as in Washington, on a clear moonless night. Seeing at the new site is consistently better than at the old one, and preliminary comparisons show it to be as good as at nearby Lowell Observatory, which has long enjoyed a reputation for excellent seeing. In these very favorable surroundings, the modernized Ritchey-Chrétien reflector should better serve both the U. S. Naval Observatory and astronomy in general.

This sign on Highway 66, about five miles west of Flagstaff, marks the side road leading to the observatory grounds. All illustrations with this article, except as noted, are official U. S. Navy photographs.

The First Determinations of Stellar Parallax—I

OTTO STRUVE, *Leuschner Observatory, University of California*

AT THE ROME MEETING of the International Astronomical Union in September, 1952, Walter Baade, of the Mount Wilson and Palomar Observatories, electrified the astronomical world by announcing a new distance scale of the universe that doubled the previously accepted scale.

The most distant galaxies observed with the 100-inch Mount Wilson reflector were now placed about a billion light-years away, instead of 500 million, and the penetrating power of the 200-inch telescope was actually twice as great as anticipated. This tremendous advance in our knowledge of the geometry of the universe came about, in part, through the slow accumulation of accurate observations by many astronomers, and partly through the skillful use by Baade and his associates of some of the first photographs obtained with the 200-inch telescope. (See *Sky and Telescope*, June and July, 1953.)

This recent astronomical revolution reminds us of another even greater one that took place 115 years earlier, when the distance scale for even the nearest stars was still in doubt. Centuries of work by many astronomers culminated in the years 1837, 1838, and 1839, with the announcements of the first reliable distances of three fixed stars, increasing the scale of the universe not by a factor of only two, but by 10 times!

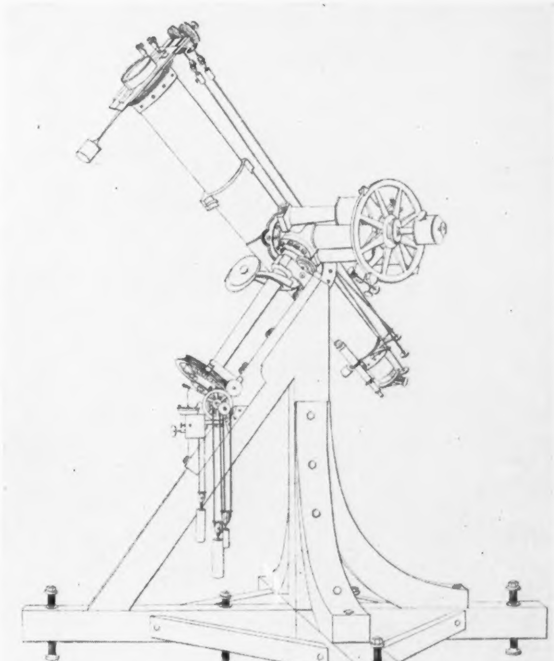
The great importance attached by astronomers of that day to this earlier advance was well stated by Sir John Herschel in 1841, in an address before the Royal Astronomical Society of London. On presenting the gold medal of the society to Friedrich Bessel, the Königsberg astronomer, for his measurement of the distance of the star 61 Cygni, Herschel said:

"I congratulate you and myself that we have lived to see the great and hitherto impassable barrier to our excursions into the sidereal universe; that barrier against which we have chafed so long and so vainly . . . almost simultaneously overleaped at three different points. It is the greatest and most glorious triumph which practical astronomy has ever witnessed. Perhaps I ought not to speak so strongly —perhaps I should hold some reserve in favour of the bare possibility that it may be all an illusion—and that further researches, as they have repeatedly before, so may now fail to substantiate this noble result. But I confess myself unequal to such prudence under such excitement. Let us rather accept the joyful omens of the time, and trust that, as the barrier has begun to yield, it will speedily be effectually prostrated."

This gold medal was regarded then, as today, to be the greatest recognition that an astronomer can hope to achieve. John Herschel's account of the penetration of the "hitherto impassable barrier" is an accurate and eminently fair appraisal of the contributions that finally brought success. Yet this appraisal was made by astronomers who knew only what had preceded the great work of Bessel, and in the passage quoted above Sir John admits the remote possibility "that it may be all an illusion."

Is there now any reason to doubt John Herschel's account, and to rewrite the history of the first parallax determination? This question was raised in 1952 by A. N. Deitch, of the Poulkovo Observatory, who wrote in the *Russian Astronomical Journal:*

"It is well known that the first reliable measurements of the distances of the stars were carried out almost simultaneously by three astronomers: W. Struve, Bessel, and Henderson. However, Struve's contributions in this field are not accorded their proper recognition, and his determination of the parallax of Vega is often described incorrectly. For example, in A. Clerke's book, *A History of Astronomy in the Nineteenth Century* (translated into Russian by V. V. Serafimov in 1913), we read on page 60: 'W. Struve, then already at Poulkovo, and making use of the new 15-inch refractor, devoted his attention to the brilliant gem in the constellation Lyra, whose Arabic name is Vega. . . .' In reality, W. Struve observed the parallax of Vega with the 9-inch refractor in Dorpat (Yuriev, now Tartu).[1] The same error occurs in A. Berry's *Short History of Astronomy* (edited with additions by P. V. Kunitzky, second edition, 1946) on page 308: '. . . W. Struve obtained for the star Vega a parallax of $\frac{1}{4}$ second of arc, from observations made at Poulkovo.' The impression has gained ground that the parallax of α Lyrae was published by Struve a year later than the investigations by Bessel and Henderson, and that the



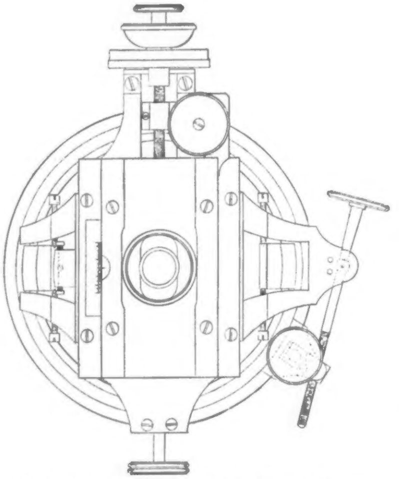
The parallax of 61 Cygni was measured by F. W. Bessel with this 6¼-inch heliometer built by Fraunhofer (as was the Dorpat refractor). The objective of this instrument was divided along a diameter, each half producing an image of a star. By shifting the half-lenses with controls operated at the eyepiece, images of two nearby stars could be made to coincide. The heliometer remained unrivaled for parallax determinations until about 1900, when it was superseded by photographic methods.

value of this parallax was in greater discord with modern data (see for example P. P. Parenago, *Textbook of Stellar Astronomy*, second edition, 1946, page 31)."

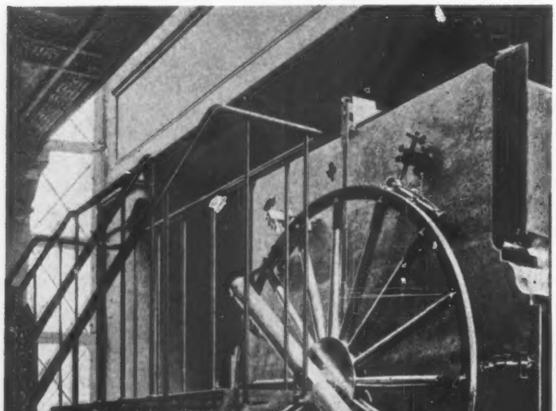
These comments involve two distinct points. First, Deitch calls attention to much confusion in current astronomical literature with regard to the chronology of the events. Second, he believes that the work of W. Struve has not been accorded its proper share of recognition.

Neither of these points is entirely new. The second was ably discussed by J. Jackson, formerly director of the Cape of Good Hope Observatory and, at the time of his historical account of stellar parallaxes, chief assistant at the Greenwich Observatory. I quote from his paper in the *Observatory* for November, 1922:

"The arguments given show how keenly astronomers a century ago felt the need for the determination of the parallax of a star and how brilliantly they tackled the problem. It will be seen how systematically every possible avenue of approach was examined, and as we read the pages of Struve we feel that the writer was certain that the solution of the problem was near, and that it was just within the reach of micrometric observation with his telescope. The hopes of many generations had remained unrealised, but Struve was not despondent—he was almost expectant when at last success did come. We have said little of what Bessel did, although he did much to improve the methods of reduction and generally inspired confidence in his results. . . . To him is usually assigned the chief merit for the actual determination of the parallax of a star. The name of Henderson is generally added for his observations of α Centauri. It is only sometimes that the name of Struve is linked with the final success. It is hoped that this article shows more clearly the greatness of the contributions made by Struve, both from the theoretical and from the observational point of view."



F. G. W. Struve used this filar micrometer on the 9-inch refractor at Dorpat to measure the distance of Vega. At the center is the eyepiece, on the rectangular box that contains the spider lines. These threads are shifted by a precision screw whose divided head is at the top of the picture. To measure position angles, the micrometer box is rotated by the tangent screw at the right, the amount of rotation being indicated by a divided circle and the two verniers.



In the 1830's, when Thomas Henderson determined the parallax of Alpha Centauri, he used a mural circle similar to this one installed at the Paris Observatory in 1819. This now obsolete instrument was used to measure the meridian altitudes of stars. The telescope turns on an axis running horizontally through the stone pier, and can point along the meridian (marked by slits in the wall and roof). A finely divided circle is fastened to the telescope, and is read by small microscopes attached to the pier face. The principle of the mural circle has serious defects, and the fact that Henderson could detect a star's parallax with one proves his ability as an observer.

The first point of Deitch's remarks was already briefly mentioned in my review[2] of W. M. Smart's *Foundations of Astronomy* (1942). In this review I wrote:

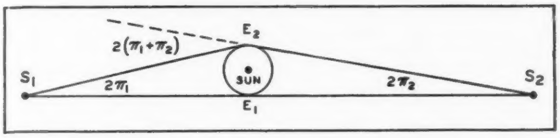
"On page 128 Smart briefly refers to the history of parallax determinations for fixed stars and repeats a historical error which has crept into the newer astronomical literature, though it contradicts some of the earlier accounts. He states that the first successful measurement of a stellar parallax was that of 61 Cygni in 1838, which was quickly followed by the measurements of α Centauri and α Lyrae. As a matter of fact, the first reliable parallax was that of α Lyrae published in 1837 in the Latin Introduction to the *Mensurae Micrometricae* [by F. G. W. Struve]. The value there given is $\pi = +0''.125 \pm 0''.055$ (p.e.). The best modern value is $\pi = +0''.121 \pm 0''.004$. The first reliable parallax of 61 Cygni was published in 1838 and was actually obtained by Bessel in that year. The important thing, however, is not, as Smart's statement might lead one to think, which parallax was determined first but which parallax actually dispelled all doubts of the contemporary astronomers that the long-searched-for effect had finally been found. There can be no doubt that the parallax of 61 Cygni, and not that of α Lyrae, gave this assurance: it had a probable error of only $\pm 0''.014$ applied to a parallax of $\pi = +0''.314$. The best modern value is $\pi = +0''.299 \pm 0''.003$. The relatively much greater uncertainty of the first parallax of α Lyrae is also demonstrated by the fact that later micrometer observations [also by F. G. W. Struve], up to 1838, gave $\pi = +0''.261 \pm 0''.025$, while observations with a vertical circle by Peters gave, in 1846, $\pi = +0''.103 \pm 0''.053$. Bessel's additional observations of 61 Cygni published in 1840 gave $\pi = +0''.348 \pm 0''.010$."

I believe it is important to distinguish the result that appeared convincing to the contemporaries of Bessel, Struve, and Henderson, from what we, with more than a century of hindsight, can recognize as the first successful penetration of Herschel's "barrier." The astronomers in the early years of the 19th century understandably mistrusted new announcements of stellar parallaxes, after scores of the best observers from Tycho Brahe to James Bradley had failed. It should also be remembered that both Struve and Bessel had been occupied with parallax measurements—all fruitless—long before they finally succeeded in 1837 and 1838.

We have already seen from the comments of Deitch that there is much confusion concerning the first parallax determination. It is easy to add further instances, such as the words of Rudolf Wolf in his standard history of astronomy[3]:

"Soon after Bessel, Wilhelm Struve also

undertook . . . a similar determination, for which he selected α Lyrae as one of the brightest and therefore presumably one of the nearest stars; he announced in his *Disquisitio de Parallaxi α Lyrae* (which appeared in 1839 as a supplement to his *Mensurae Micrometricae*) that he had obtained a parallax of 0″.26, or a distance of 16 million million German miles."



An early but unsuccessful method of measuring the distances of the stars.

We have already seen that Struve's first announcement was in 1837, in the *Mensurae Micrometricae* itself, and was there given as +0″.125. Wolf mentions Henderson only casually, "Afterwards similar determinations were made by Thomas Henderson, John Brinkley, Otto Struve, and Peters." Actually, Henderson's observations of Alpha Centauri at the Cape of Good Hope were begun before those of Bessel and Struve, but he delayed the discussion and publication of his results until 1839.

F. Becker[4] assigns all three discoveries to 1838. "Almost simultaneously (1838), Bessel succeeded in measuring the parallax of 61 Cygni, W. Struve that of Vega, and Henderson that of Alpha Centauri." E. Lebon writes[5], "In 1838 Bessel found the parallax of 61 Cygni, thanks to the excellent heliometer constructed in 1829 by Fraunhofer. W. Struve was the first to apply successfully the method of Galileo, obtaining the parallax of α Lyrae in 1840." Henderson is not mentioned at all. In reality, Bessel and Struve both used the method suggested by Galileo, to be described below. They differed only in the form of instrument; Bessel used a heliometer with a divided object glass, Struve employed a filar micrometer in the focal plane of the telescope.

Other instances of the confusion may be added. W. Brunner[6] mentions only Bessel. E. A. Fath's *Elements of Astronomy* assigns the three determinations to 1838, and then states, "Bessel, Struve and their successors used an instrument called a heliometer." As we have just noted, Struve used a micrometer. E. Zinner[7] also attributes the first determination to Bessel in 1838, and mentions for Vega Struve's later value of 0″.26, and for Alpha Centauri Henderson's result of 0″.92. R. L. Waterfield[8] and R. A. Sampson[9] discuss only the parallaxes of 61 Cygni and Alpha Centauri.

With regard to the latter, Sampson makes an interesting comment. "Henderson has sometimes been blamed for undue caution and delay. This seems a wrong view of the case; with the means at his disposal, caution and confirmation were an obligation. After his results were confirmed, the Council [of the Royal Astronomical Society] felt that he too should have recognition. But they missed the right opportunity for action. In 1843, the material was before them, and no name was proposed for the Medal. In 1844, November, Henderson's name was put forward, but in the same month he died."

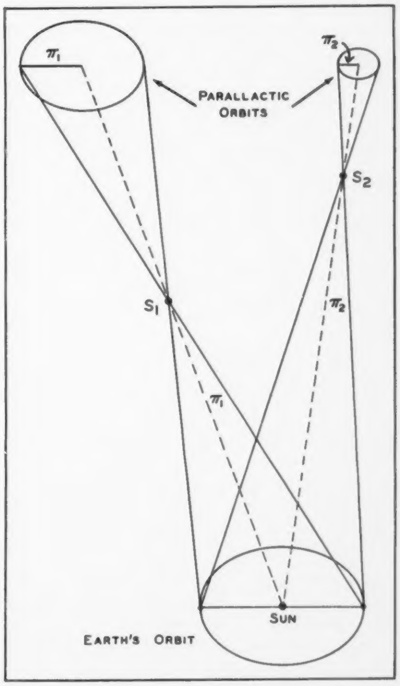
The recent (1948) German edition of Newcomb-Engelmann's *Populäre Astronomie* attributes the first two determinations to Bessel and Struve, whose second parallax (of 1839) is given for Vega. Henderson's result is mentioned as approximately simultaneous with these. Of Bessel's work it is said, "Here for the first time the distance of a fixed star was determined by a method deserving full confidence."

These examples show that the history of the first successful parallax measurements has often become confused in recent writings. Before reconstructing the actual sequence of events in 1837-39, it is well to consider the observational problem, to help us appreciate the climate of opinion among the astronomers of that era.

The earliest attempts by astronomers to measure the distances of the fixed stars used the method which is illustrated in the diagram above. Two stars, S_1 and S_2, were chosen such that they made an angle of 180 degrees when the earth was at E_1. Half a year later, when the earth was at E_2, the angle should be less than 180 degrees, by an amount equaling twice the sum of the stars' parallaxes, $2\ (\pi_1 + \pi_2)$. If the angle is not exactly 180 degrees to begin with, or if both stars are not in the plane of the earth's orbit, the result is slightly more complicated, but the basic idea remains the same.

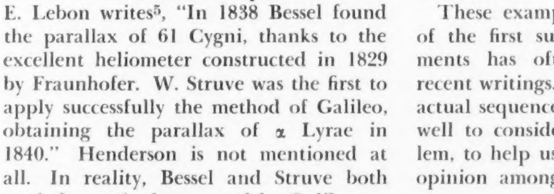
Since it is not feasible to measure directly angles of about 180 degrees on the sky, this method requires the determination of the absolute co-ordinates of the two stars—a process involving many sources of error. Nevertheless, this method was used in the 16th century by Copernicus. He found no detectable effect, and hence concluded that the stars must be at least 1,000 times more distant than the sun. With more refined instruments Tycho Brahe also failed; there was no measurable effect. Hence, either the stars were 1,000 times as far as the sun or the earth did not revolve around the sun. Tycho chose the second alternative; to him it was inconceivable that the stars should be so remote.

Later investigations, up to and including the earlier work of Bessel and Struve, made frequent use of this method, but the results were always negative.



The parallax of a star is the angle at the star subtended by the radius of the earth's orbit.

However, another method had already been suggested in the 17th century by Galileo and independently by Huygens. Their idea was to measure the *difference* between the parallactic displacements of two stars near each other in the sky, but at different distances from the sun. We may refer to such a pair of stars as an optical double star. The orbital motion of the earth causes both objects to describe small ellipses on the celestial sphere, larger for nearer stars and vanishingly small for very distant ones. We could, for example, measure repeatedly the angular separation between the two stars in the diagram, and from this infer the difference between their parallaxes $\pi_1 - \pi_2$. If the more distant component is so remote that its parallax is negligible, the


The objective end of a Dollond heliometer of 1755. One of the two halves of the object lens is shifted by a screw. Bessel's observations of 61 Cygni were made with a new heliometer of greatly improved design.

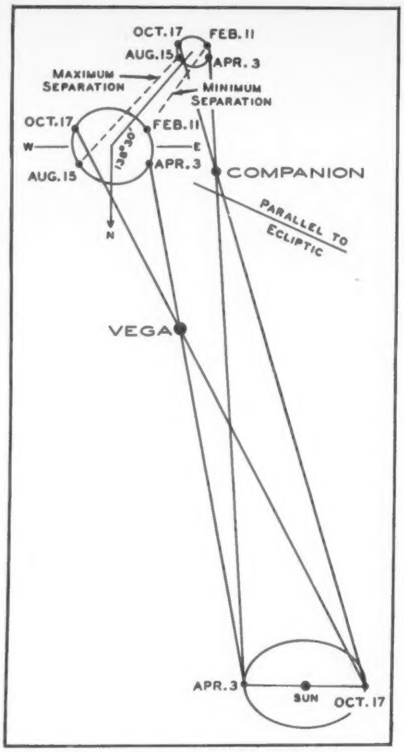
result of the measurements gives us π_1.

This method very largely eliminates the systematic errors of the first one, because these errors should be nearly the same for two neighboring stars. It appeared so promising to William Herschel, at the end of the 18th century, that he undertook the systematic observation of very many visual double stars. However, the fruit of his work was not the measurement of a stellar parallax, but the discovery that most visual double stars are physical systems, with their two components at almost identical distances from us.

Of course there are some real optical double stars, but their recognition had to await much more observational work. Vega is such a system; it has a 10.5-magnitude companion 43 seconds of arc away, which fails to share the proper motion of Vega. The latter moves in a straight line at a uniform velocity with respect to the companion. Our diagram applies to the case of Vega. Think of the two parallactic ellipses as projected on the background of the celestial sphere and notice that the angular separation of the stars is a maximum on August 15th of each year, and a minimum on February 11th. However, the companion star is actually so much more distant than Vega that its parallax is negligible in comparison, and the faint star can be regarded as a reference point in measuring the bright star's changes in apparent position.

There is also a periodic change in the position angle of the line joining the components. But this effect is small, because the angular separation of the components is almost 200 times greater than the major axis of the parallactic ellipse. Moreover, the measurements of position angle are affected by systematic errors depending on the orientation in the sky of the line joining the stars at the time of observation. The errors in the measured separations are known to be less serious.

Before we take up the historical use of these methods, something should be said of another effect that also causes annual shifts in star positions—the aberration of starlight. It was discovered accidentally by Bradley over two centuries ago, when he attempted to find the parallax of Gamma Draconis from absolute measurements of this star's celestial co-ordinates. Both aberration and parallax cause the



As described in this article, W. Struve used the differential method for finding the distance of Vega.

stars to appear to describe small ellipses in the sky, as shown below.

Consider first the effect of parallax on a star in the plane of the earth's orbit (in the ecliptic). When the earth is at E_1, the star is seen at S_1 on the celestial sphere; when the earth has come to E_2, the star appears at S_2, and so forth. Thus, during the year the star describes a straight line from S_1 to S_2 to S_3 and back to S_4 and S_1. The total extent of this oscillation is less than one second of arc for all stars except Alpha Centauri.

But in this same example there is also a much larger annual oscillation, again in a straight line, which is caused by the aberration of light. When the earth is at E_2, an observer pointing a telescope at the star must incline his instrument in the forward direction of the earth's motion by 20 seconds of arc. This is the angle at the hypotenuse of a parallelogram whose sides are the velocity of light (300,000 kilometers per second) and the earth's orbital velocity (30 kilometers per second).

The parallactic and aberrational oscillations need never be confused with one another, since the former requires that the star be farthest from its mean position when the earth is at E_1 and E_3 (in quadrature with the sun). The aberrational displacement, on the other hand, reaches its maximum when the earth is at E_2 (opposition) and E_4 (conjunction). The entire extent of the aberrational oscillation is over 40 seconds of arc—many times larger than the parallax of even the nearest star.

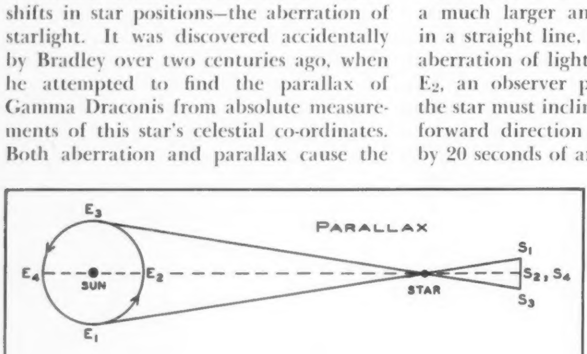
For a star at the pole of the ecliptic, both the aberrational and parallactic oscillations become small circles in the sky, the former with a radius of 20 seconds, the latter only a fraction of a second of arc. Here again it is easy to distinguish between the effects, for when the earth is at E_1 the star occupies different positions in the two small circles; the location of S_1 in the aberrational circle lags a quarter of a year behind that of S_1 in the parallactic circle. Thus astronomers can readily disentangle the two effects.

Next month we shall pass from geometry to observation, and see how astronomers used these methods in the protracted search for stellar parallax that was crowned by success in 1837-39.

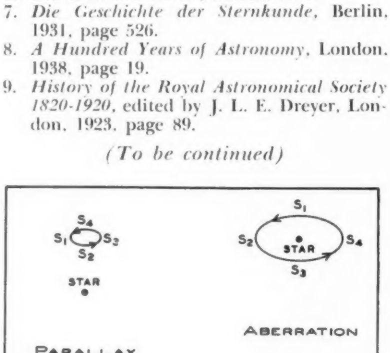
NOTES

1. This quotation from Miss Clerke's book may have been altered by the translator, V. Serafimov. The English text on page 35 of Miss Clerke's *A Popular History of Astronomy During the Nineteenth Century* (4th edition, 190[illegible]) reads: "Struve made a similar, and somewhat earlier trial with the bright gem of the Lyre, whose Arabic title of the 'Falling Star' survives as a time-worn remnant in 'Vega.'"
2. *Astrophysical Journal*, *96*, 159, 1942.
3. *Geschichte der Astronomie*, Munich, 1877, page 543.
4. *Geschichte der Astronomie*, Bonn, 1947, page 66.
5. *Histoire Abrégée de l'Astronomie*, Paris, 1899, page 92.
6. *Die Welt der Sterne*, Zurich, 1947.
7. *Die Geschichte der Sternkunde*, Berlin, 1931, page 526.
8. *A Hundred Years of Astronomy*, London, 1938, page 19.
9. *History of the Royal Astronomical Society 1820-1920*, edited by J. L. E. Dreyer, London, 1923, page 89.

(To be continued)



These diagrams illustrate the aberrational and parallactic displacements of a star, in the plane of the ecliptic (left) and at the pole of the ecliptic (right). Compare the positions of the earth in its orbit with the correspondingly labeled apparent positions of the star in the aberration and parallax orbits.



A California Gauger of Star Clusters

JOHN IRWIN
Goethe Link Observatory
Indiana University

Robert J. Trumpler (1886-1956), whose studies of star clusters provided one important foundation for our present knowledge of the Milky Way.

ROBERT JULIUS TRUMPLER died on September 10, 1956, a few weeks short of his 70th birthday. His name will always be associated with fundamental researches on galactic clusters, observational tests of general relativity theory, the absorption of light in our galaxy, and the discovery of the Trumpler stars.

Born October 2, 1886, in Zurich, Switzerland, the son of a cotton-mill owner, he graduated from the Zurich Gymnasium in 1905, from the University of Zurich in 1908, and received his Ph.D. degree from Göttingen in 1910. His Göttingen dissertation was on a photographic method for the determination of meridian transits of stars.

After four years as an astronomer with the Swiss geodetic commission, he came to this country in 1915 as an assistant at the Allegheny Observatory, where he worked mainly in the field of stellar astrometry (stellar parallax and zone catalogue observations). There he also began studies of the galactic clusters that were to be his primary interest for the rest of his life.

He first went to the Lick Observatory as a Martin Kellogg fellow in 1919; his rise in rank was rapid and he became Astronomer there in 1929. In 1938 he came down from Mt. Hamilton to Berkeley, being appointed professor of astronomy at the University of California on the retirement of A. O. Leuschner. He officially retired in 1951, but lived an active scientific life his last years in his Aptos, California, home at the northern end of Monterey Bay.

My own first experience with Professor Trumpler was indirect, through the facile pen of Henry Norris Russell writing in the April, 1939, *Scientific American* on "Berenice's Hair." I can vividly recall my feelings of interest and excitement on a Washington, D. C., bus one hot afternoon in the late spring, as I read of Trumpler's astrometric, radial-velocity, and spectral-type techniques for separating the Coma cluster members from the nonmembers. My interest was heightened by the knowledge that I was to start my graduate work at Berkeley in a few months and would have Trumpler as a teacher.

One of my real regrets concerning these graduate studies was that curriculum necessities made it impossible for me to do more than partly audit Trumpler's courses in practical astronomy and statistical astronomy. Trumpler was considered by his students to be a careful and meticulous teacher; but more important, he brought to the Students' Observatory a much-needed research and observational viewpoint in regard to the important problems in stellar astronomy. His influence on many students both at Berkeley and at Lick was profound.

His working hours were long. He frequently drove down Mt. Hamilton on a Monday morning direct from a long stretch of observing in order to fulfill his Berkeley commitments. I well remember his telling me of being "called on the carpet" in his youth for not having put in a full day's work after a night of observing.

He was an eager and efficient observer. The two-prism 6-inch spectrograph that he designed and used for so many years with the Lick 36-inch refractor was at least as efficient as any of its contemporaries. He desired that nonreflecting coatings be given the lenses and prisms in this spectrograph. They markedly improved its speed and, when applied to other Lick spectrographs, such coatings increased their speeds by a factor of 2 to 2.5.

The Lick expedition to Wallal, Australia, to test the relativistic shift of starlight at the solar eclipse of September 21, 1922, was most successful. It turned out that the interagreement of the results from both the 15-foot and 5-foot cameras was satisfactory, and the weighted mean of 1.75 ± 0.09 seconds of arc is one of the best determinations ever obtained for the relativistic shift. It agrees exactly with theory and has a probable error of only five per cent. This value was derived from 87,000 bisections of more than 3,000 star images. The responsibility for testing the instruments, for the observations themselves, and for the long and careful analysis was almost entirely Trumpler's. His discussion, however, was vigorously criticized by both C. L. Poor and the Potsdam observers. The latter (Freundlich, von Klüber, and von Brunn) obtained 2.24 seconds of arc from their own observations in 1929, and 2.2 seconds from a re-reduction of the Lick observations.

The main point of contention is the plate scale, which, in theory, can be separated from the relativistic shift, provided that the stars measured are uniformly distributed around the sun. But the 1929 eclipse star field was lopsided; a line could be drawn through the center of the sun placing 17 of the 18 stars used on one side. Trumpler's least squares reduction of the Potsdam measures, in which he added the scale factor as a new unknown, gave 1.75 ± 0.13 seconds of arc, and showed that the inverse square law of deflections was fulfilled; it also gave a much better representation of the Potsdam measurements than the original Ger-

man discussion did. We still have the problem of an independent determination of plate scale with an accuracy of at least one part in 100,000, but modern techniques at favorable eclipses should substantially reduce both systematic and accidental errors.

Trumpler's great love was for galactic clusters. His preliminary results, published in 1930 as Lick Observatory *Bulletin* 420, form a classic paper which should be required reading for all graduate students in astronomy. In Seares' words of 1940, "Trumpler's investigations of the diameters of a hundred open clusters of the Milky Way (galactic clusters) initiated a period of observational activity which still continues. With that event, and perhaps for the first time, it may be said that the systematic study of absorption phenomena had become a going concern. A bulky literature is already on our shelves." As a consequence of this work, Trumpler was elected to the National Academy of Sciences in 1932.

He used two separate methods for estimating the distances of the clusters. The first was by plotting spectral type versus apparent photographic magnitude and comparing with the H-R diagram; the second was from the angular diameters of the clusters. The dispersion in real diameter is large, and the latter method was successful only because Trumpler was able to classify the clusters—by their appearance—into various groups, the spread in diameter within each group being substantially reduced. The classification was by the number of stars in the cluster, their concentration, and the distribution in apparent magnitude within each cluster.

The distances obtained by the two methods could only be brought into general agreement by the assumption of a general absorption in the galactic plane of 0.67 (photographic) magnitude per 1,000 parsecs. Without this assumption, the first or photometric method gave distances that made the diameters of the clusters increase markedly with distance. Trumpler also showed that the absorption was much less in visual than photographic light, with a consequent reddening of distant objects.

Although it was left to the Wisconsin observers with their powerful photoelectric methods many years later to determine accurately the variation of interstellar absorption with wave length, Trumpler's results were convincing and had far-reaching implications. This triumph of observation and deduction is the more remarkable when one considers that the observations were made with moderate-sized telescopes, slow spectrographs, and even slower photographic plates, and with a system of magnitudes that would be rejected out of hand by the modern photometrist. Many of Trumpler's exposures with the Crossley slitless spectrograph were five to seven hours long and enabled him to classify the spectra of stars to fainter than 14th magnitude.

One of Trumpler's main conclusions in this 1930 paper has not stood the test of time. His derived space distribution of 334 galactic clusters led him to a Milky Way system only 5,000 parsecs in radius with the sun close to the center, a result remarkably similar to the Kapteyn universe that his own absorption results were so instrumental in disproving. We would explain this result today by saying that galactic clusters cannot be distinguished as such at distances of more than a few kiloparsecs, because of both interstellar absorption and the dense background of faint stars. What was needed, in order to resolve the conflict, was more evidence. Perhaps all the evidence necessary would have been provided by a walk on a clear winter night on the South African high veld with the nuclear bulge of our galaxy high overhead showing a striking similarity to many photographs of edge-on spirals.

Trumpler's final results on clusters are still to come. In chats with me at the Berkeley meeting of the American Astronomical Society and the Astronomical Society of the Pacific, just two weeks before his death, he expressed the hope that the final discussion of his thousands of spectroscopic observations of cluster stars would be completed by the end of this year. His mind and body were active and his enthusiasm was keen despite his long struggle with leukemia. Astronomy is the poorer for the sudden passing away of this kindly man. He was one of our truly great astronomers.

Amateur Astronomers

Mars' Approach Attracts Record Crowds

OBSERVING parties sponsored for the general public by many societies and organizations throughout the country brought out multitudes of interested persons when Mars came within 35,200,000 miles of the earth on September 7-8. In several localities there were giant traffic jams and long lines through the early morning hours at telescopes set up for viewing.

At the Warner and Swasey Observatory in East Cleveland, Ohio, more than 7,000 persons stood in queues for hours to take a 10-second peek through several telescopes set up by the observatory. Of this number, a total of 1,600 also attended nine lectures given throughout the evening by Drs. J. J. Nassau and Victor Blanco. At 4 o'clock in the morning, when a large cloud hid the planet, about 100 persons were still waiting their turns at the instruments.

In Dallas, the Texas Astronomical Society was confronted with over 15,000 people at its new observatory site 25 miles south of the city. The society publicized its Mars party through local newspapers and on radio and television stations, expecting only 1,000. The sheriff's department estimated 5,000 automobiles jammed roads leading to the observing site, causing a huge tieup, and all available police were sent to the locality when the traffic came to a standstill over a wide area. Club president E. M. Brewer reported that many persons remained for the entire night and that at sunrise a crowd was still on hand looking at the red planet and sunspots.

Well over 150 attended a Mars party on September 4th, which prompted the Kern Astronomical Society of Bakersfield, Calif., to hold another well-attended one on September 8th. Drake Observatory in Des Moines, Iowa, also had a large number of persons at its Martian open house for the general public.

The foregoing are but a few examples from the large number of reports that have come in to *Sky and Telescope*. An estimate of the number of persons who attempted to view Mars through telescopes during August and September runs well over a hundred thousand.

THIS MONTH'S MEETINGS

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Lone Star Gas Co. auditorium. Nov. 26, motion picture of total eclipse of the sun.

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., City Hall. Nov. 12, Dr. Frank Hancock, "Comets and Their Orbits."

Long Beach, Calif.: Excelsior Telescope Club, 7:30 p.m., home of Dick Norton, 3157 Chatwin Ave. Nov. 2, Charles Tarwater, "Asteroids."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Nov. 7, Dr. Lyle B. Borst, New York University, "Vestiges of Creation."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. Nov. 3, Dr. William D. Markowitz, U. S. Naval Observatory, "The Redefinition of the Second, the Definition of the Second in Terms of the Tropical Year, and How the Astronomer Determines It."

NORTHWEST CONVENTION

All six societies of the Northwest Region of the Astronomical League were represented among the 71 amateurs in attendance at the ninth annual regional convention, at Yakima, Wash., September 1-3.

The conference was marked by a double theme, in which visual satellite observing was stressed on the first day and the opposition of Mars on the fol-

lowing day. On September 1st, Dr. Armand Spitz, co-ordinator of visual satellite observations, described plans for tracking the artificial moons. His talk was preceded by a film titled Horizon Unlimited.

Carl P. Richards, Salem, Ore., gave a talk on Mars, setting the scene for the second evening's observing party at Bethel Ridge, which is 90 miles from Yakima at an elevation of 6,000 feet. Several telescopes were in continuous use by the 50 persons who made the trip, although Mars was not observed too well because of atmospheric conditions. Many other objects, however, were viewed with satisfaction.

Officers for the coming year are: Norman C. Dalke, Seattle, chairman; Preston Adler, Spokane, vice-chairman; Mrs. W. Henry Kobs, Portland, recording secretary; Roy Van Alstyne, Puyallup, Wash., executive secretary; Donald E. Tooley, Portland, treasurer; and the undersigned, regional representative.

Next year's meeting will be held in Spokane.

EDWARD J. NEWMAN
324 W. Yakima Ave.
Yakima, Wash.

HARTSVILLE, SOUTH CAROLINA

We have recently formed the Hartsville Astronomical Society with 15 active members and several more who show a casual interest. We meet on the second Tuesday of the month at the recreational center of the Twitty Methodist Church, when talks are given by members and astronomical films are shown. Further information may be had from the writer.

BILL HOPKINS
Box 423, Hartsville, S. C.

GREAT LAKES CONVENTION

About 100 amateurs attended the first annual convention of the Great Lakes Region at Indianapolis, Indiana, September 1-2, making this one of the largest Astronomical League regional conventions ever held.

Among the papers given on the opening day were a talk on radio astronomy for the amateur by George J. Nielson and Ivan E. Loftis of Ohio State University, a contribution on Mars from Walter Haas, and a discussion of the visual observing program of artificial satellites by G. R. Wright.

The evening was spent at the Holcomb Observatory and Planetarium of Butler University, where Dr. Harry Crull gave a planetarium demonstration and the 38-inch Fecker telescope was used for viewing Mars.

The following afternoon's session was devoted to papers by juniors from Indianapolis; Louisville, Ky.; Danville and Columbus, Ohio; Detroit, Battle Creek, and Pontiac, Mich.

A trip to Goethe Link Observatory climaxed the conference. A picnic, given by the host society, preceded an observing session with the 36-inch telescope and other smaller instruments. Dr. James Cuffey was host for the observatory.

The following regional officers were elected: William Garnatz, Indianapolis, chairman; Mrs. Jane Gann, Columbus, vice-chairman; Mrs. Olive Grunow, Detroit, secretary; Mrs. Mabel Chircop, Pontiac, assistant secretary; Charles Strull, Louisville, treasurer; and the undersigned, regional representative.

CHARLES S. JOHNSON
12489 Mendota Ave.
Detroit 4, Mich.

NEW YORK A.A.A. MARKS 30TH YEAR

In celebrating their 30th anniversary this season, the 600 members of the Amateur Astronomers Association in New York City have embarked on another full program. Two of their most important projects will be observing the total lunar eclipse on November 17-18 and the earth satellite observing program. Climaxing the year will be a special anniversary dinner next May.

Two new classes are being offered, "The Making of Modern Astronomy" and "General Science in Astronomy." Five other courses are given, in elementary astronomy, recent astronomical advances, constellation study, home study, and mirror making.

Officers for the coming year are: Robert L. Frey, president; Jane S. Davis, 1st vice-president; with Aileen A. Pindar, 2nd vice-president; E. M. Paulton, 3rd vice-president; Roy A. Seely, 4th vice-president; Henry T. Kirkebye, treasurer; and George V. Plachy, secretary. A free information booklet, "Enjoy the Stars," may be obtained from the secretary, A.A.A., 201 West 79th St., New York 24, N. Y.

ADELAIDE, SOUTH AUSTRALIA

Membership in the Astronomical Society of South Australia rose from 100 to 150 following a recent exhibition of its members' telescopes at an annual hobbies show in Adelaide.

The main display was a large show card reading, "How To Make a Telescope for £8 10s" (about $20). Parts on a stand were connected with colored ribbon to the card. Also shown were reflectors of 8- and 6-inch aperture, and a small comet seeker. Astronomical pictures were lent by the University of Adelaide.

We meet monthly for lectures, except during our summer months, and have an annual exhibition and field trips. Our members have almost 90 telescopes, ranging in size to 12-inch. Two dozen members are also enrolled in a telescope making course.

Adelaide's population is about half a million. Low rainfall (21 inches) gives us clear skies most of the year, though temperature "shimmer" is a summer problem.

R. L. SANGSTER
111 Esplanade
Brighton, South Australia

☆ ☆ SKY AND TEACHER ☆ ☆

Sponsored by the
Teachers' Committee of the American Astronomical Society

THE NSF SUMMER INSTITUTE ON ASTRONOMY

THE BEAUTIFUL CAMPUS of Wisconsin State College in Eau Claire was the site of the 1956 summer institute on astronomy, sponsored by the National Science Foundation. The purpose of the conference was to bring the latest astronomical ideas and developments to 50 selected teachers and supervisors of science and astronomy from smaller colleges and a few high schools. This was the first effort of the NSF to improve the teaching of astronomy, and thus develop scientists, by means of a summer institute.

Preparations for the conference were made largely by its director, William A. Calder, of Bradley Observatory at Agnes Scott College, and by the assistant director, Charles Koelsche, of Wisconsin State College. The other faculty members of the institute were W. H. Pinson, Massachusetts Institute of Technology; Frank K. Edmondson, Indiana University; R. William Shaw, Cornell University; Freeman D. Miller, University of Michigan; and Carl K. Seyfert, Vanderbilt University.

The four-week program opened on June 18th with a welcome by the president of Wisconsin State College, W. R. Davies, which was followed by registration. A first-day highlight was a luncheon with an address by Edward M. Palmquist, NSF program director for education in the sciences.

A typical day had lectures all morning, a discussion session in the early afternoon, and an observational meeting after dark on clear nights. The first lecturer each morning for the full four weeks was Dr. Pinson. His talks covered the solar system in general, but particularly meteors and meteorites, and the structure and evolution of the earth. Dr. Seyfert, who taught only during the first two weeks, spoke about astronomical instruments, the elementary physics of astronomy, and spectral classification of stars. During the second week Dr. Shaw lectured on the teaching of astronomy. The third week brought two new faculty members, Drs. Edmondson and Miller. The former dealt with galaxies and the expanding

telescopes were stored in half of his double garage. During the last week of the institute, most members spent all of one night observing Mars.

From time to time visitors came to the institute. There was a luncheon on June 22nd for Raymond J. Seeger, acting assistant director of NSF, who spoke on the nation's acute need for scientists. A two-day visitor was Herbert N. Williams, who brought a Spitz planetarium and portable dome. He gave evening demonstrations both to the institute and to the townspeople.

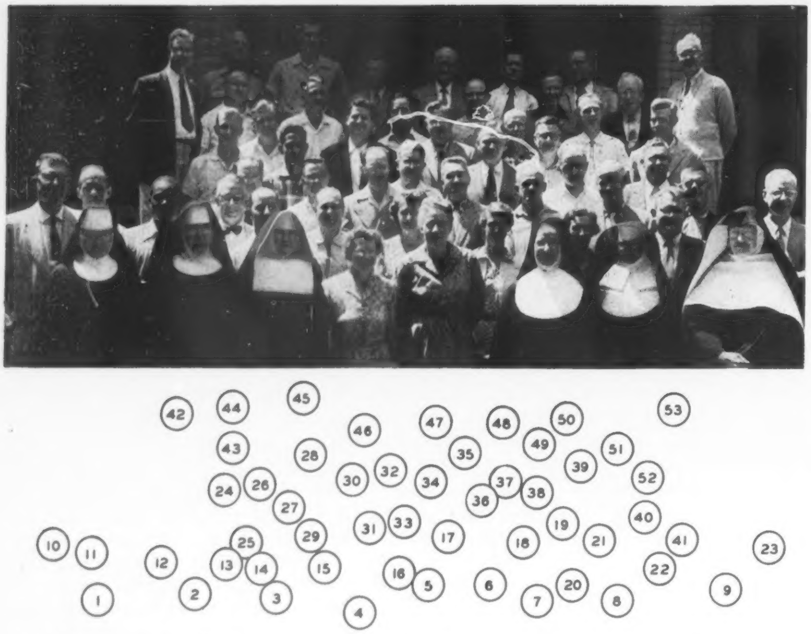
Three public lectures were given during the conference: Dr. Pinson on Mars in 1956, Dr. Edmondson on exploring the Milky Way, and Dr. Miller on comets. A local amateur telescope maker, S. W. Casey, assisted with the night observing programs, bringing his own handiwork, a beautiful 4½-inch refractor.

Both the college and the city of Eau Claire were gracious hosts. The college had a steak fry and a "watermelon cuttin'" for institute members and college faculty. There were free tickets to an Eau Claire Braves baseball game. Two softball games were played between the college faculty and the institute, but the official scores were withheld. During the free part of most afternoons, many members went swimming at Big Falls on the Eau Claire River, and others headed for nearby fishing streams and lakes.

There was a farewell banquet on July 12th, and after classes the next day the institute was officially closed. On their way homeward from Eau Claire, many of the members stopped at Yerkes Observatory by prior arrangement. One group at least had the unexpected privilege of looking through the 40-inch refractor.

A unanimous opinion was expressed by institute staff and members alike. It was a very profitable month.

CHARLES N. COCHRAN
Mathematics Dept.
West Virginia University
Morgantown, W. Va.



In this photograph of the participants in the summer institute on astronomy, two lecturers were absent: Dr. Frank K. Edmondson, Goethe Link Observatory, and Freeman D. Miller, University of Michigan Observatory.

universe; the latter described the stellar system within 1,000 light-years of the sun. One of Dr. Miller's lectures was on comets. Dr. Calder gave an occasional talk, principally about solar phenomena and radio astronomy.

All but one of the lecturers used a large number of lantern slides; Dr. Edmondson even claimed to have brought 25 pounds of them with him. Dr. Miller, however, gave everyone a fine portfolio containing lecture notes and 10 large astronomical photographs, and he used these pictures in place of slides. The notes of all the lectures during the institute were duplicated and distributed to the participants.

At the informal afternoon meetings astronomical movies were shown nearly every day. The nature of these sessions varied from day to day with the current teaching staff, visitors to the institute, or the whims of the members. At one interesting meeting Marvin J. Pryor demonstrated some of his visual aids for teaching astronomy. During these sessions, members of the staff were induced to tell about their home observatories and their own research programs. There was much discussion, of course, of new work being done in all fields of astronomy.

The night sessions were generally led by Dr. Pinson with the trim 6-inch reflector he brought from M. I. T. In all, about 15 small telescopes were used in Dr. Koelsche's back yard, which is situated on higher ground than most of Eau Claire, and it proved to be a fine place for observing in the clear Wisconsin air. The

KEY TO PHOTOGRAPH

1. Sister Ganzaga Plantenberg, College of St. Benedict, St. Joseph, Minn.
2. Sister Maxine Zeller, Mt. St. Scholastica College, Atchison, Kans.
3. Sister M. Clarita Mangold, Rosary Hill College, Buffalo, N. Y.
4. Louise C. Stolle, Berea College, Berea, Ky.
5. Winifred A. German, Eau Claire, Wisc.
6. Patricia Gehrt, Teachers College, Lowell, Mass.
7. Sister Helen J. Sanschagrin, College of St. Catherine, St. Paul, Minn.
8. Sister Mary Grace Burns, Georgian Court College, Lakewood, N. J.
9. Sister Mary Felice Vaudreuil, Mt. Mary College, Milwaukee, Wisc.
10. Bill B. Thomas, Brock C. S. D. 52, Weatherford, Tex.
11. Herman J. Hays, Polytechnic Inst. of Puerto Rico, San German, P. R.
12. James S. Sutton, Miles College, Birmingham, Ala.
13. W. S. Wooddell, Concord College, Athens, W. Va.
14. David Vitrogan, Pratt Institute, Brooklyn, N. Y.
15. J. Russell Smith, Eagle Pass, Tex.
16. Dorothea S. Griffin, Harpeth Hall School, Nashville, Tenn.
17. Carl K. Seyfert, Vanderbilt University, Nashville, Tenn.
18. Frederic Beddow, Wayne University, Detroit, Mich.
19. Ira Gwinn, Morningside College, Sioux City, Iowa
20. Ruth C. Smith, Clark Howell School, Atlanta, Ga.
21. Allan Dickie, Kent State University, Kent, Ohio
22. George Y. Muse, Druid Hills High School, Emory University, Ga.
23. Manfred Olson, Wisconsin State College, Milwaukee, Wisc.
24. Charles H. Johnson, DePauw University, Greencastle, Ind.
25. Earl F. Young, Glenbrook High School, Northbrook, Ill.
26. Charles Koelsche, Wisconsin State College, Eau Claire, Wisc.
27. Alexander A. Hall, Albany State College, Albany, Ga.
28. John Semon, Teachers College, North Adams, Mass.
29. Arland H. Johnson, Wisconsin State College, Eau Claire, Wisc.
30. Charles N. Cochran, West Virginia University, Morgantown, W. Va.
31. William Azbell, Wartburg College, Waverly, Iowa
32. Stanley Hruska, Children's Museum, Detroit, Mich.
33. Everett Miltenberger, Miami University, Oxford, Ohio
34. R. William Shaw, Cornell University, Ithaca, N. Y.
35. Roger Randall, Wentworth Institute, Boston, Mass.
36. William H. Pinson, Mass. Inst. of Tech., Cambridge, Mass.
37. Jacob A. Rinker, Eureka College, Eureka, Ill.
38. Robert Maurer, Chico State College, Chico, Calif.
39. Clarence B. Lindquist, University of Minnesota, Duluth, Minn.
40. Arnold J. Hoffman, Eastern Illinois State College, Charleston, Ill.
41. George Pitluga, State Univ. of New York Teachers Coll., Oswego, N. Y.
42. Julian C. Yoder, Appalachian State Teachers College, Boone, N. C.
43. James Vandehey, Abbotsford, Wisc.
44. H. S. Mendenhall, Oklahoma A. and M. College, Stillwater, Okla.
45. George L. Bullis, Wisconsin State College, Platteville, Wisc.
46. William A. Calder, Agnes Scott College, Decatur, Ga.
47. Ralph H. Coon, Salem College, Salem, W. Va.
48. J. O. Collins, Wisconsin State College, Eau Claire, Wisc.
49. W. Norman Smith, University of Wyoming, Laramie, Wyo.
50. Harris A. Palmer, Parsons College, Fairfield, Iowa
51. Robert L. Price, Joliet High School and Junior College, Joliet, Ill.
52. David Telfair, Earlham College, Richmond, Ind.
53. William J. Hooper, Principia College, Elsah, Ill.

NEWS NOTES

CHANGES IN THE SIZE OF THE SUN?

A controversy of long standing involves the diameter of the sun. Several astronomers have thought it changes from year to year during the sunspot cycle, with a total range of a few tenths of a second of arc. Other investigators have been unable to detect any variation.

To settle this question, P. J. D. Gething has analyzed observations of the sun made at Greenwich Observatory with the Airy transit circle between 1851 and 1939. Each year's work gave about 100 separate determinations of both the horizontal and vertical diameters of the sun. Mr. Gething discussed in particular detail the observations for the period 1915 to 1936, when the work of five regular transit-circle observers with exceptionally long periods of service provided the most suitable data.

The English astronomer finds small and irregular year-to-year differences in the observed diameters that are mainly due to personality differences between the observers. Otherwise, the Greenwich data do not confirm the variations in size of the sun deduced by L. Gialanella from observations at Campidoglio and Monte Mario observatories in Italy—generally considered the strongest evidence for change.

This study is reported in *Monthly Notices* of the Royal Astronomical Society, *115*, No. 5, page 558.

ANNOUNCEMENT

Since the second issue of this magazine, in December, 1941, the News Notes page has been conducted by Dr. Dorrit Hoffleit. The 15 years during which she has reported the news to our readers have been ones of rapid astronomical growth. Her broad research experience—in fields as diverse as stellar spectra, variable stars, meteors, star distances, and the history of astronomy—has given her special qualifications as an interpreter of current advances.

We regret that because of changes in editorial operations, resulting from the growth of *Sky and Telescope*, it is no longer feasible for Dr. Hoffleit to conduct the department, and news items will henceforth be prepared by members of the editorial staff.

Associated with Harvard Observatory since 1929, Miss Hoffleit received her doctorate from Radcliffe in 1938. During the war years she was a mathematician at Aberdeen Proving Ground, and on her return to Harvard in 1948 became a consultant to the Ballistic Measurements Laboratory at Aberdeen.

Recently, Dr. Hoffleit has been teaching astronomy at Wellesley College. She is now a research associate at Yale University Observatory, and in June, 1957, will also become director of the Maria Mitchell Observatory, Nantucket, Mass., when the present director, Miss Margaret Harwood, retires. C. A. F.

HALLEY TERCENTENARY

The 300th anniversary of the birth of Edmond Halley will be celebrated in London on November 22nd by the British Astronomical Association, at a special meeting at the rooms of the Royal Society. There will be an exhibition of many Halley relics, including the transit instrument he used as second Astronomer Royal, and a lecture will be given on his life and work.

RADIO OBSERVATIONS OF MARS

Heat radiated from the planet Mars has been measured with the 50-foot radio telescope of the Naval Research Laboratory, Washington, D. C., by C. H. Mayer, T. P. McCullough, and R. M. Sloanaker. With the antenna tuned to a wave length of 3.15 centimeters, more than 100 scans were made through the position of Mars near the time of its closest approach to the earth in early September. Water vapor in terrestrial clouds weakens centimeter radio waves, so that clear skies were needed when making these observations.

The Navy radio astronomers tentatively conclude that the mean temperature of Mars is slightly lower than the freezing point of water, but this is an average over the disk, the tropics being warmer and the polar regions colder. The radiation from Mars at 3.15 centimeters is much weaker than that from Venus measured with the same radio telescope earlier this year (see page 435 of the August issue).

COMET CROMMELIN RECOVERED

The long overdue detection of Crommelin's periodic comet has finally been reported by Mrs. L. Pajdusakova in Czechoslovakia on September 29th. It thus becomes Comet 1956g, the seventh discovery of the year. On that date the object was nine degrees from its predicted position and of magnitude 10—considerably fainter than expected. Apparently perihelion passage occurs on October 24th, five days later than had been calculated by M. P. Candy and J. G. Porter, in the 1956 *Handbook* of the British Astronomical Association. Comet Crommelin was in Leo Minor when it was recovered, but its rapid southward motion will make it a difficult object for Northern Hemisphere observers by November.

The period of this comet is 27.9 years; it had been detected in 1818 by Pons, in 1873 by Coggia and Winnecke, and in 1928 by Forbes. The name Comet Crommelin was given to it in 1948 to honor A. C. D. Crommelin, whose calculations demonstrated that these were all returns of the same periodic comet.

IN THE CURRENT JOURNALS

OXYGEN IN THE STARS AND NEBULAE, by Paul W. Merrill, *Leaflet* No. 328, Astronomical Society of the Pacific, September, 1956. "In many respects the earth constitutes a fair chemical sample of the universe but it lacks the huge amounts of hydrogen and helium which stars and nebulae contain. Thus, while oxygen is the most abundant terrestrial element, in the universe as a whole it competes with neon for third place, both being far behind hydrogen and helium."

MESONS, HYPERONS, AND ANTI-PROTONS, by H. S. W. Massey, *Endeavour*, July, 1956. "Recent research, which has resulted in the identification of a new range of fundamental particles, has shattered the belief that all matter is constructed from a relatively few simple units."

MEDICAL PROBLEMS INVOLVED IN ORBITAL SPACE FLIGHT, by Hubertus Strughold, *Jet Propulsion*, September, 1956. "It is my purpose in this paper to discuss the medical problems involved in the second phase of space operations, namely, that of circumplanetary space flight or satellite flight. This is full-fledged space flight in its simplest form: full-fledged, because all of the strange environmental and motion conditions associated with space flight are encountered; in its simplest form, because the vehicle's movement is uniform with regard to speed and trajectory."

ONR ASTRONOMY PROGRAM

During the year July, 1957, to June, 1958, the Office of Naval Research will continue its modest program in support of basic research in astronomy and astrophysics. Dr. K. Aa. Strand, Dearborn Observatory, is chairman of its seven-man advisory panel. Applications for support of research in astronomy must be submitted by December 15th. Details can be obtained from Earth Sciences Division, Office of Naval Research, Washington 25, D. C.

FORT WORTH ASTRONOMICAL CENTER PLANNED

Texas Christian University plans to erect an observatory and planetarium on its campus at Ft. Worth, it has recently been announced by its president, M. E. Sadler. The new astronomy building is to contain a 12-inch catadioptric telescope, other smaller instruments, a spectroheliograph, laboratories, classrooms, a planetarium, and other facilities. Funds are now being raised.

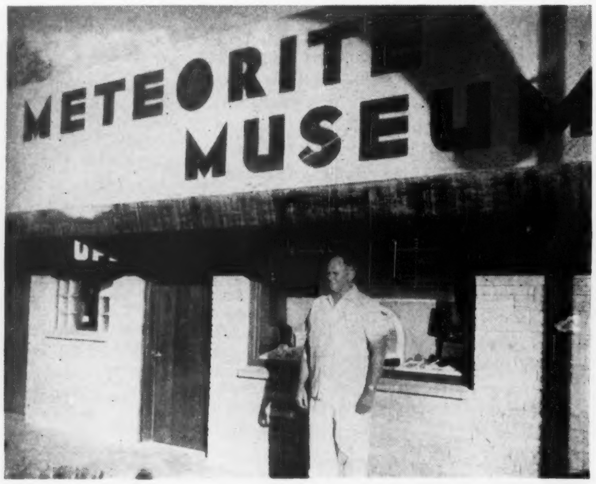
In conjunction with this project, Texas Christian University expects to add an astronomy department to its science division.

One of the astronomical institutions at Flagstaff is the Atmospheric Research Observatory of Arizona State College, seen in the foreground of this aerial view of the ponderosa pine forest. Dr. Arthur Adel is its director. Photograph courtesy Arizona State College.

Flagstaff Is Scene of Western Convention

Here and on the following three pages are photographs gathered on the occasion of the recent conventions at Flagstaff, Arizona, of the Western Amateur Astronomers and the Association of Lunar and Planetary Observers.

At the Flagstaff station of the U. S. Naval Observatory, Dr. Arthur Hoag explains to the visiting amateurs the operation of the 40-inch reflector, which is described in the article beginning on page 4.

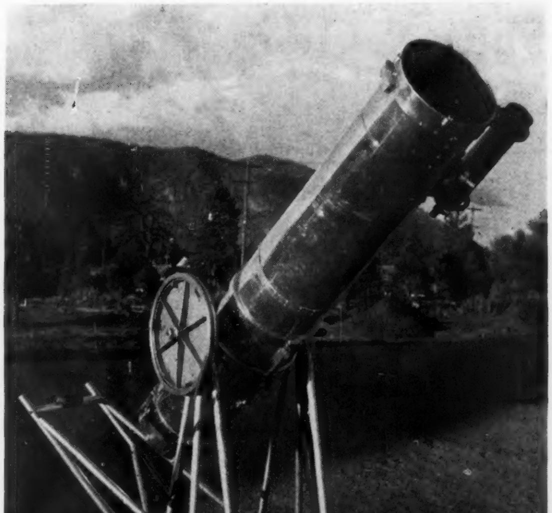


Among the many amateurs who visited the American Meteorite Museum at Sedona was Thomas P. West, Mill Valley, Calif., chairman-elect of the Western Amateur Astronomers. From a color photo by Barbara Federer.

The convention of Western Amateur Astronomers, August 29-31, 1956, on the steps of the Flagstaff high school. Photograph by Fronske Studio.

REGISTRATION for the combined conventions of the Western Amateur Astronomers and the Association of Lunar and Planetary Observers was well over 260 persons. The general chairman was T. R. Cave, Jr., and T. A. Cragg was in charge of the program. George Perkins planned the physical arrangements, and Les Mawhinney directed the publicity. All the sessions for papers were held in the modern auditorium of the Flagstaff high school.

An unexpected diversion occurred during the Thursday evening banquet, at which Dr. Otto Struve received the Blair award for service to astronomy and the interests of amateur astronomers. He had changed his acceptance-speech subject to that of the first parallax determinations, in which his ancestor, F. G. W. Struve, played a major role (see page 9), and during the talk was to display a copy of an old and rare astronomical book. But the volume had disappeared from where he had put it on the stage just behind the speakers' table.



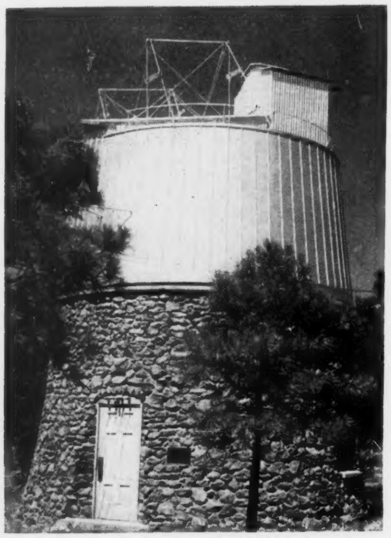
One of the finest telescopes at the convention was this 16-inch reflector of 105-inch focal length. It was built by Frank Grow, of Burbank, Calif., a member of the board of directors of the Los Angeles Astronomical Society. The instrument is here set up as an altazimuth, but it can be quickly made an equatorial by tilting the entire mounting to the left, to rest on the handles. Massively built, it weighs some 500 pounds, and is transported on a special trailer behind Mr. Grow's automobile. He can load and unload the telescope without assistance. The clock drive is both sidereal and lunar.

Consternation reigned in the banquet hall, while all hands searched feverishly. Dr. Struve rose to the occasion by giving the original speech, on stellar evolution, at the end of his first one! Then the panel of experts convened, but the question of who had the book was uppermost in everyone's mind. Finally, the missing volume was found, and Dr. Struve graciously presented it to the library of the Western Amateurs. It had been taken home by an electrician working on the loudspeaker system, who mistook it for an instruction manual!

Among the other convention speakers were Dr. Albert G. Wilson, director of Lowell Observatory, who described the Lumicon television system used for observing Mars; Clyde Tombaugh, White Sands Proving Ground, on Mars; Dr. Dinsmore Alter, director of Griffith Observatory, on the moon; and Dr. Armand Spitz, Smithsonian Astrophysical Observatory, who discussed artificial satellite observing.

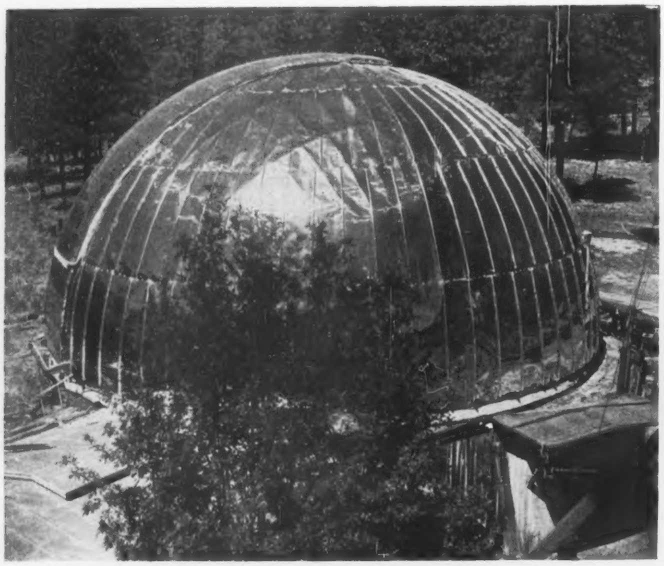
Next year, in August, the convention will be held at the Leuschner Observatory, Berkeley, Calif.

For their star party on August 29th, the Western Amateurs were guests of Lowell Observatory, on Mars Hill overlooking Flagstaff. In the background of this view is the housing of the famous 24-inch Clark refractor, here seen past the entrance of the observatory library. The telescope was erected by Percival Lowell for the favorable 1894 opposition of Mars; for half a century it has been used by E. C. Slipher to make visual and photographic observations of the red planet. At the open house, long lines of amateurs awaited their turn to view Mars as it was displayed on the screen of a Lumicon attached to the telescope. The amateurs brought nearly 100 other telescopes to Mars Hill for an evening of observing under perfectly clear skies.



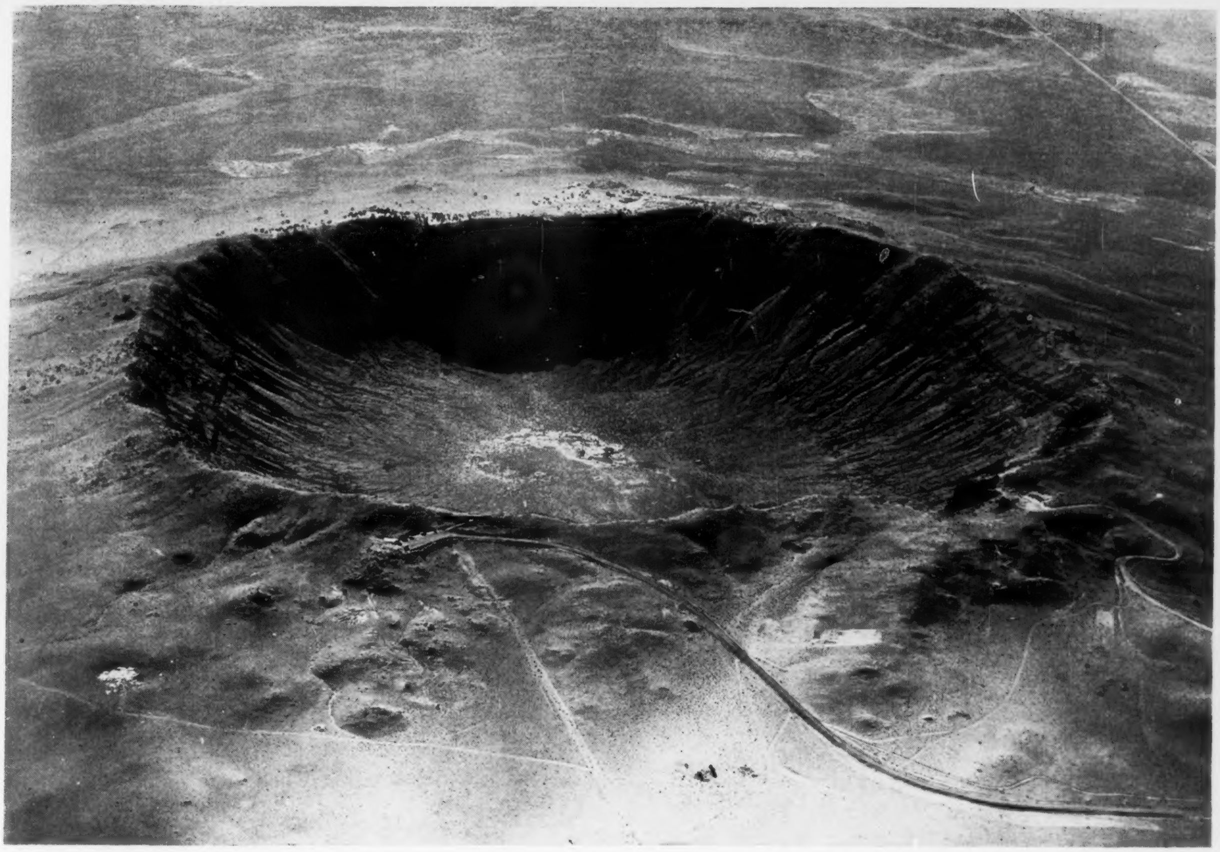
Percival Lowell for many years believed in the existence of another planet beyond Neptune. He erected the 13-inch photographic refractor housed in this building and organized a systematic search for such an object. The telescope became world famous in 1930, when Pluto was discovered by Clyde Tombaugh, then on the observatory staff, after a very extensive series of plates had been taken with the 13-inch. Much of the present work of the instrument is the observation of comet positions. The structure on the roof of the building provides a means of access to the shutters for snow removal, as winter in the Flagstaff area can be quite severe.

AT LOWELL OBSERVATORY



Left: The 42-inch Clark reflector on Mars Hill has a compact canvas dome which has recently been sheathed in gleaming aluminum.

Below: This is the housing of the 20-inch Cassegrainian reflector, newest of Lowell Observatory's telescopes.



On the afternoon of August 30th, a cavalcade of the convention delegates took an hour's drive east from Flagstaff to the great Barringer meteorite crater, where they were admitted without charge, courtesy of the Barringer Crater Co. The crater is three miles around the top, 4,150 feet across, and deeper than the Washington Monument is high. This recent aerial view was taken by John Farrell, of Ft. Worth, Tex., who hired a small plane to carry him over the crater.

AT BARRINGER METEORITE CRATER

A smooth road is seen along the lower right of the aerial photograph, leading toward the center to the new museum that is perched on the north rim of the crater. From walls of glass on the south side of this building, visitors obtain a breath-taking view of the entire crater.

Many of the amateurs scrambled down the path to the bottom of the crater, where they examined the weather-beaten equipment that was once used to drill beneath the crater floor in search of meteoritic iron. The actual meteorite mass is believed to be buried under the south rim.

The Waning Crescent Moon

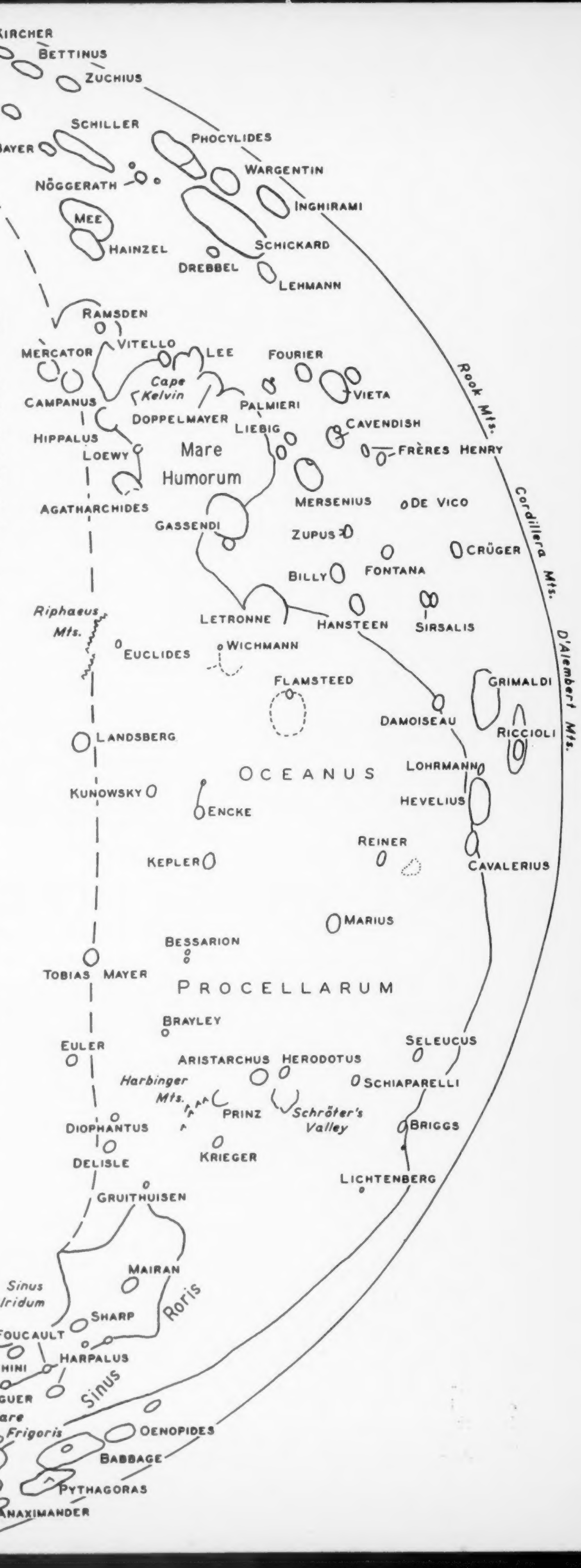
AN OUTSTANDING feature of the waning moon is the brilliant crater Aristarchus, with the bright rays that extend outward from it. Above it in this picture is Kepler, also the center of a ray system, located in Oceanus Procellarum, the largest of all the lunar "seas." Near the bright limb of the crescent is the gray oval Grimaldi, a crater whose floor is one of the darkest areas on the moon. Toward the south (top) of the crescent is Mare Humorum, bordered by the ruined craters Doppelmayer and Lee. In the north, Sinus Iridum, the Bay of Rainbows, is fringed by mountains lit by the setting sun.

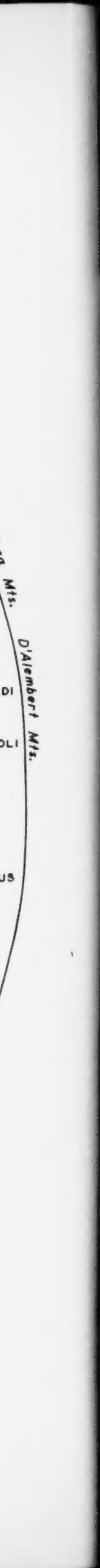
Although our satellite has been under telescopic scrutiny for more than three centuries, it is still incompletely mapped, especially in the extreme edge regions that are only occasionally brought into view by the moon's libration. In this marginal zone much detail awaits detection by amateurs with moderate-sized telescopes.

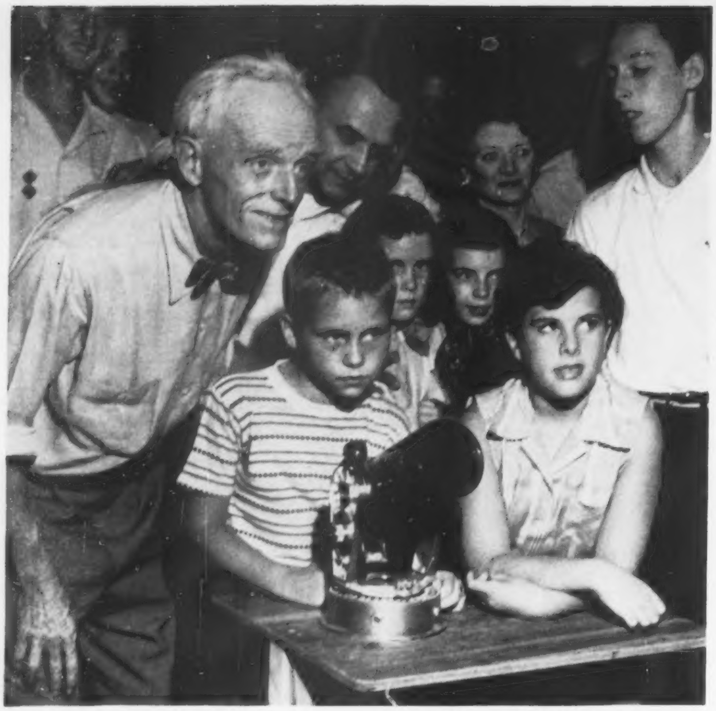
Another branch of amateur research concerns the curious changes in the appearance of certain markings, such as dark spots on crater floors, as the solar illumination varies during the month. To settle whether such a change is real or only apparent is a difficult but absorbing task for the persevering observer. Other amateurs with larger telescopes are systematically searching the lunar surface for unrecorded clefts and for the peculiar low rounded domes that have attracted much attention lately.

Professional astronomers are taking an increasing interest in the moon, using the powerful techniques of photoelectric photometry, infrared and radio observations, precise positional measurements from photographs, and other methods. Selenography today flourishes as never before.

This photograph, enlarged from a negative taken with the Lick Observatory 36-inch refractor, on August 20, 1938, by J. H. Moore and J. F. Chappell, shows the moon 24.3 days past new. It combines the four larger-scale pictures in the issues from June to September.




D'Alembert Mts.



Mr. Russell shows the moon to two young visitors with his Questar.

Pulitzer prize-winner Dr. Dietz and party guest.

Fifteen thousand men, women, and children attended two stargazing parties staged by the Cleveland Press this summer, the 28th year these parties have been given under the direction of Dr. David Dietz, science editor of the Scripps-Howard newspapers. In co-operation with the Cleveland Astronomical Society and Cleveland Amateur Telescope Makers Club, telescopes are set up in the park — thirty were shown this year, under the supervision, as in past years, of James L. Russell, Cleveland attorney, who is the city's number one amateur astronomer and a research associate of the Cleveland Museum of Natural History. Over a public address system, astronomical talks were given for those who waited in line to look through the telescopes.

QUESTAR GOES TO A STAR PARTY

. . . and "steals the show" at Cleveland

We have long been prejudiced against testimonial advertising because it is constantly used to promote everything from patent medicines to the little wizard gas saver for your car. But when a competent authority says something about our product that we are too conservative to say, we thought you too might be interested. Recently we received two letters from Questar owner James L. Russell that quite frankly astonished us. The photographs above, by Bob Tomsic of the Cleveland Press, are used through the courtesy of Dr. David Dietz, who wrote the description of the star party above, and who tells us that his friend Mr. Russell has been well known and highly regarded in Cleveland for many years.

Here are excerpts from Mr. Russell's letter:

"Enclosed is clipping from local press concerning the 28th Annual Press-Cleveland Astronomical Society Star Party. All of the telescopes used with the exception of two or three were made by the owners in my telescope making class at the Cleveland Museum of Natural History. We had one 4-inch Clark refractor and a 6-inch Mogey, two of the best objectives I have ever seen. All of the amateurs and several professionals had a chance to compare the Questar and I would say it stood the test. . . . On nebulae it was superb, Saturn stood out like a jewel in the sky and so did Mars. Those who knew what they were looking at, those with looking experience, pronounced it perfect, and many, many of the inexperienced novices just out for a look remarked, 'Gee, this jobbie shows up better'n that big one over there,' meaning the Mogey or the Clark. In fact, Questar sort of stole the show. Hundreds of people crowded around the table. They sat down comfortably on a chair before the table to use the Questar and nobody could understand how an instrument so small could give an image as clear and sharp as the Clark and the great big Mogey.

"Faint markings on Mars could easily be seen by the more experienced, but the moon —ah, the moon—I have never seen such a sight as through this Questar. It stays steady on the table I have built, and with elbows resting there, body relaxed, it is so comfortable to just sit and wonder, while changing from low to high power and back again.

" . . . . During the last few days I have been able to give the Questar a good workout on Mars. . . . . I find it best in the 80x eyepiece. I am able to see the polar cap quite plainly and several of the dark markings on the disk. Of course the rings and their separation on Saturn are perfection itself. . . . I have a 6-inch Mogey refractor to set up right beside the Questar for comparison. This Mogey objective is an excellent glass and I have not as yet seen any reflector which would outperform it. And I do not mean just stargazing but performance on the really tough objects like extremely close doubles and planetary detail. The Questar is the only instrument I have compared to it thus far that I may say can give my Mogey a hard time. . . . But where I am most pleased seems to be in two departments quite apart from mere observation of celestial objects . . . . The terrestrial uses for this Questar are legion. Even a good pair of binoculars does not compare with the Questar because the Questar can be set down anywhere, on the ground, in a tree crotch, or even attached to a car window. And the view stands perfectly still. At one of the recent star parties which was held on a promontory along the lake shore, I was requested to turn the machine on the brilliantly lighted city shore line twelve miles away. Dr. David Dietz was astonished and delighted at being able to tell the time of night from the face of a tower clock twelve miles away. The clock could not be seen or even located at all with the unaided eye.

"For bird- and flower-study at a distance this instrument would be an extremely valuable addition to any school or museum research department. I am going to loan my instrument to Dr. Gavin, a pathologist at a large Cleveland hospital, to see if students or even assistants cannot use it for observation in surgery or for photography of same.

" . . . . I am very happy with the machine; it was a lot of money but I feel that Questar presents a great many possibilities that cannot be had with any type of ordinary telescope. It is worth the money to anybody who will really use it.

"You are at liberty to use my letter or letters in your advertising if you choose.

Yours very truly,

JAMES L. RUSSELL"

See our previous advertisements for details and prices on De Luxe and Field Model Questars and accessories, or write

Questar Corporation
New Hope, Pennsylvania

BOOKS AND THE SKY

BETWEEN THE PLANETS

Fletcher G. Watson. Harvard University Press, Cambridge, Mass., 1956. 288 pages. $5.00.

THIS BOOK presents a concise account of the smaller bodies in the solar system — asteroids, comets, meteors, and meteorites. Its author spent eight years at Harvard College Observatory, and is currently associate professor of education at Harvard. His wide experience in both astronomy and education is reflected in the sense and style of his book.

One of the original Harvard books on astronomy, this is a thoroughly revised edition of a work which first appeared in 1941. In his two-page preface, Dr. Watson sketches the progress that astronomers have made since that time in the study of the interplanetary material. He mentions the new researches on the origin of the solar system, the comet cloud theory, and Whipple's comet model. Referring to improved instrumentation, he tells us that "increasingly fast cameras, sensitive and stable photoelectric cells, and the use of radio techniques have provided types of information not previously available." All these topics are discussed at greater length in the appropriate sections of the main text.

The plan of the revised edition follows closely that of the first version. There are 11 chapters: an introductory survey of the solar system, two chapters on asteroids, two on comets, three on meteors, two on meteorites, and one on the zodiacal light. In the first edition, the illustrative plates were included in the text; in the present volume they are collected at the end of the book. This arrangement was probably necessary to keep down the book's cost; but it burdens the reader, who is referred to a picture on almost every other page, and must then thumb through the plate section to find it.

Dr. Watson stresses statistical information. There are graphs that show the characteristics of cometary and asteroidal orbits, brightnesses of comets and asteroids, and frequency of meteors at different times of the night. Dr. Watson gives thoroughly up-to-date lists of asteroids that cross the earth's orbit, meteor showers that have a known association with comets, radio-detected daytime showers, and terrestrial meteorite craters.

The reviewer notes that there is no description of the mechanical theory of cometary forms. This rather involved mathematical explanation of coma and tail structure, developed in the 19th century by Bessel and Bredikhin, is discussed by N. T. Bobrovnikoff in J. A. Hynek's *Astrophysics*, pages 312-29. A book list for further reading would, in the reviewer's opinion, be a useful addition to this and other books in the Harvard series.

A few minor slips appear. On page 6, it is said that six elements (a, e, i, Ω, ω, T) suffice to determine the orbit of any body moving "within the solar system." This should be modified to read "around the sun," since a seventh element, the combined mass of primary and secondary, must be given explicitly whenever it is not unity, for example, in the case of a satellite revolving around a planet. On page 9, the term "minimum temperature" might better be replaced with "mean temperature of a rapidly rotating sphere."

On page 47, the statement that, among periodic comets seen at more than one apparition, "only Halley's comet has an orbital inclination exceeding 90°," is probably too strong. Two other periodic comets which, according to the computers of their orbits, have been seen at two apparitions (1742 = 1907II and 1366 = 1866I) have inclinations over 90 degrees.

On page 55, the date of appearance for Biela's comet should be changed from 1815 to 1806. On page 56, line 11 from the top, the name should be spelled West-

phal. In the table on page 169, the density of Mercury should be given as 5.7 ± 0.4; this corresponds to R. L. Duncombe's new derivation of Mercury's mass from its perturbations of the motion of Venus.

Despite these few imperfections, Dr. Watson's book is generally accurate, comprehensive, and well written. Its coverage is not duplicated in any other single semipopular text I know. It is a good book to have in any astronomical library.

CHARLES GASTEYER
Van Vleck Observatory
Wesleyan University

METEORS

T. R. Kaiser, editor. Pergamon Press, New York, 1955. 204 pages. $8.50.

A SYMPOSIUM on meteor physics was held at the Jodrell Bank Experimental Station, near Manchester, England, in July, 1954. Its proceedings have now been published as a special supplement to the *Journal of Atmospheric and Terrestrial Physics,* containing 39 papers by 37 authors. The contributors include a fair percentage of the leading names in meteoric astronomy at the present time.

As would be expected, the subjects dealt with cover a wide range. The categories containing most papers are radio observations of meteors, the basic theory of meteor luminosity and ionization, and the problems of meteoric dust and zodiacal light particles in the solar system. There are also papers on meteor orbits, atmospheric winds, the physical structure of meteors, telescopic meteors, and studies of the ionosphere as related to meteors. It is a pleasure to see four papers from the U. S. S. R. included. One of these, by V. G. Fessenkov, gives a very interesting summary of the study of the remarkable Sikhote Alin meteorite (see *Sky and Telescope,* May, 1956, page 300).

The papers in this volume are quite uneven in quality and style. Some are merely brief summaries or abstracts of work published elsewhere in more detail. Others are general surveys of meteor programs now in operation or planned for the immediate future. Among the more complete papers are a useful summary of certain lines of attack in dealing with the physical theory of meteors, by R. N. Thomas; a note on meteor fragmentation, by L. Jacchia; discussions of radio meteor echoes, by T. R. Kaiser and D. W. R. McKinley; N. Nicolet's study of meteor ionization as related to the E-layer; B. J. Levin's discussion of the physical theory and structure of meteors; and contributions on meteor orbits, by M. Plavec and by F. L. Whipple and R. F. Hughes.

A number of small errors and apparent arithmetical mistakes in formulas have been noted. A more serious fault occurs in a report by H. K. Kallmann, where

SMITHSONIAN ASTROPHYSICAL OBSERVATORY

BULLETIN FOR

Visual Observers of Satellites

NUMBER 3 | 60 GARDEN STREET, CAMBRIDGE 38, MASS. | NOVEMBER, 1956

MOONWATCH Preparations Swing Into High Gear

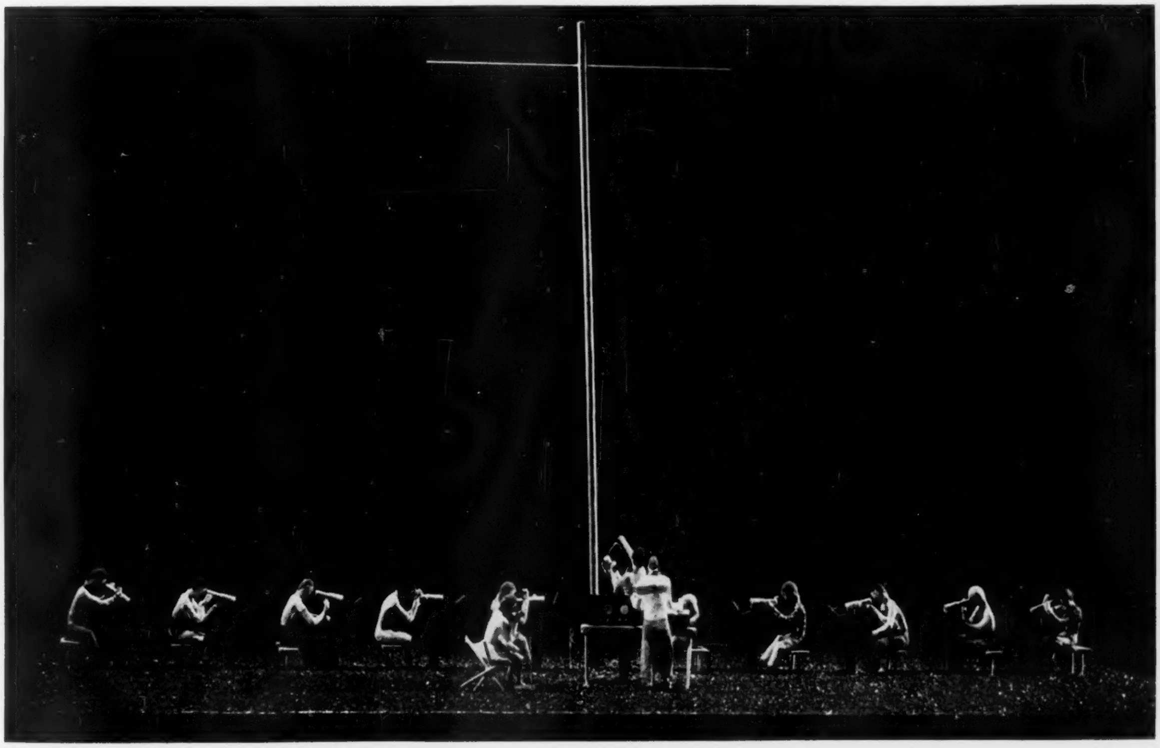
Volunteer satellite observers are speeding up efforts to organize their stations and to equip and train their teams. The emphasis is on immediate readiness to go into operation in observing artificial satellites, simulated or real.

The first major spur to this activity was the announcement that the first nationwide satellite alert would be held between Thanksgiving and Christmas (*Bulletin* No. 2). The second development came in mid-September at the Barcelona conference of the International Geophysical Year. There Dr. Sydney Chapman, president of the Special Committee for the IGY, announced that the United States and the Soviet Union are co-operating in their plans for artificial satellites, and that similar instruments and techniques would be used for tracking both American and Russian satellites.

An international network of MOONWATCH stations may soon be a reality. At Barcelona, each IGY country concerned was asked to appoint a co-ordinator for satellite observations. And at its Rome congress, the International Astronautical Federation volunteered its co-operation and facilities in establishing MOONWATCH stations in many countries. In particular, Sr. T. Tabanera, of Buenos Aires, heads an ad hoc committee to expedite MOONWATCH programs in the IAF. Through his kindness, also, each *Bulletin for Visual Observers of Satellites* will be translated into Spanish.

From coast to coast, interest in the observing program is steadily growing. More teams are needed, especially in the western part of the United States.

ARMAND N. SPITZ
Coordinator of Visual Satellite Observations



The general appearance of the line of observers, their instruments, and the central mast to mark the meridian, is seen in this model constructed by Frank McConnell.

VI. Information for Station Leaders

A. Simulated Satellites. For the first observing alert in late 1956, an artificial satellite actually in its orbit will not be needed. A number of the observing stations (selected at random) may be able to see a simulated satellite, according to plans now under way. These simulated satellites will be airplanes flying at an altitude that will make their motors inaudible, with a course and speed approximately duplicating the apparent motion of an artificial satellite. Each plane is to carry a light that will match the expected brightness of the satellite, as seen from the ground.

The proposed flights would be made over only a few stations during the alert, but whether or not a simulated satellite passes over a station will not affect the value of the observing test. The purpose is to evaluate the teams already registered with the Smithsonian Astrophysical Observatory. Professional astronomers and other official representatives of the coordinator will study the MOONWATCH volunteers in action. They will report to the coordinator on the station layout, instruments, training, and particularly the observational methods of each group.

An analysis of the reports from all stations—whether or not a simulated satellite has been observed—should give the coordinator valuable information about the efficiency of each group. Scientifically reported, businesslike operation of a station with negative observing results will be more creditable than a poorly organized report of the passage of a mock satellite.

The first alert will be held in the late afternoon, spanning the evening twilight hours. About two weeks advance notice will be given. Later alerts will take place on shorter notice, some of them in predawn twilight. Instructions on communications techniques will be distributed in advance.

B. Recommended Optical Equipment. The prototype MOONWATCH station was established at Silver Spring, Maryland, at the home of G. R. Wright, chairman of the national advisory committee. There technically skilled amateur astronomers assisted Mr. Wright in systematic tests of about 30 different optical instruments that had been proposed for visual tracking of artificial satellites. (General requirements for telescopes to be used at MOONWATCH stations were described in *Bulletin* No. 2.)

It was concluded that the instrument described in the following section of this bulletin by R. H. Dellar met the requirements as well as any telescope that could be constructed at reasonable cost. The prototype instrument, made by Hoy Walls, Washington, D. C., has an unusually large field and great brilliance of star images. Telescopes differing from this in only minor details were independently devised by Arthur S. Leonard, Davis, Calif., and Roy N. Griffin, Los Altos, Calif.

Whether a monocular or binocular is better for satellite observing is often asked. The question has been submitted to numerous experts, whose unanimous decision is that a monocular is almost as effective as a binocular having the same field, aperture, and magnification. Wide-angle binoculars meeting the observing specifications are generally unavailable and would be costly; therefore the question seems settled in favor of monoculars for MOONWATCH teams.

C. Station Sponsorship. In many communities, obtaining the equipment required for the operation of a MOONWATCH station is a major problem facing observing teams. Some amateurs, however, in addition to volunteering their services, have offered to provide themselves with telescopes and other equipment. Most of the early teams were organized on this basis, but as the number of stations is increased the problem of equipment becomes serious.

Throughout the United States, observing groups have found that private business or public service organizations are willing to help. Radio stations, newspapers, insurance companies, automobile agencies, and municipal governments have agreed to defray the relatively small cost of setting up a station so local volunteers could participate in the nationwide program.

In Phoenix, Arizona, Carl Bimson, president of the Valley National Bank, has announced that his institution will erect and outfit a complete satellite observing station on the roof of its skyscraper office building. This will include space for storing equipment between observing sessions, and even facilities for serving hot beverages to the observers.

The Evansville, Indiana, Junior Chamber of Commerce is covering the cost of setting up and equipping a station on the roof of the science building at Evansville College. This volunteer team will be under the joint direction of the astronomy department of the Evansville Museum of Arts and Sciences and of the physics and astronomy department of Evansville College.

In St. Louis, H. C. Grigg, president of the Seven-Up Company, has offered to install a station on the flat roof of the downtown office building that is national headquarters for his firm. Plans include a windbreak for the comfort of winter observers. Volunteers at Walnut Creek, California, found sponsorship from the local pipefitters' union. Members of the Mather Air Force Base chapter of the Institute of Navigation announced that they would support a large team of trained observers. They hope their example will stimulate similar participation at other Air Force bases.

Members of the Ground Observers Corps in many parts of the country have requested information on volunteering their services. Col. Broun H. Mayall, director of civil defense at the headquarters of Continental Air Defense Command, Colorado Springs, has stated that official permission for the Ground Observers Corps to co-operate in the MOONWATCH

program has been given by the Secretary of the Air Force.

D. Station Registration. At this time, a pressing responsibility of each group leader is the immediate registration of the firm intention to proceed with the operation of a satellite observing station. *This registration must be in the form of an official letter addressed to the coordinator, giving the following data:* (1) Name, address, and telephone number of the leader, his assistants, and all approved observers. (2) Description of the observing site, with its longitude and latitude to the nearest minute of arc, or closer if possible. (3) The sponsorship, if any, of the group. (4) The availability of communications. (5) Description of the timing equipment to be used. (6) A general report on weather conditions at the station, with special reference to sky transparency at morning and evening twilight. This last information can be obtained from the local weather bureau or from personal observations.

Receipt of this letter from a leader will be regarded as the formal registration of his station. Groups will be notified of their acceptance by the coordinator. Immediately, each individual observer will be placed on the mailing list of this bulletin.

E. Correspondence. As explained in *Bulletin* No. 1, it is only by participation in an organized group that the individual observer can contribute significantly to the MOONWATCH program. From now on, therefore, all contacts with the Smithsonian Astrophysical Observatory will be directly between the coordinator and the members of registered observing teams.

Beginning now, all communications should be addressed directly to the Coordinator of Visual Satellite Observations, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38, Mass., and NOT to members of the national advisory committee, a change from previous procedure. Members of the advisory committee will continue to help in development of observational operations, in screening and evaluating observing groups, but they are no longer asked to act as clerical assistants in mailing bulletins or answering general inquiries. Special problems that arise will be referred to committee members for personal handling or advice.

VII. Design of a MOONWATCH Telescope

In *Bulletin* No. 2, Section III, it was recommended that a MOONWATCH telescope have an objective diameter of 45 to 55 millimeters, a magnifying power of 6x to 7x, and a field of view of 10 to 12 degrees. The systematic tests at Silver Spring (mentioned in Section VI) show that size of field and light-gathering power are the main criteria; magnifying power is relatively unimportant.

The telescope described here provides a 12½-degree field with impressive image brightness, and has a magnification of 5.5x. The parts cost less than $20 and can be put together easily by a skilled amateur. There is a small amount of spherical aberration at the edge of the field, but this is of little consequence. The exit pupil is slightly larger than necessary, but using a longer-focus objective would lessen the field of view. We feel that this monocular represents the best performance consistent with availability and low cost. All optical parts are war-surplus items that should be readily obtained from supply houses.

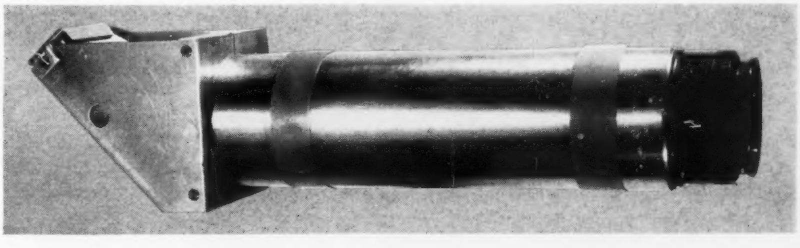
The specifications given below are not rigid, but if they are followed as closely as possible standardization of satellite observing methods will be facilitated.

The eyepiece chosen is a wide-angle Erfle of 1¼-inch focal length, advertised as having a field of 68 degrees. It contains a threaded focusing mount, making it easy to adapt it to the aluminum tube. The objective is 51 millimeters in diameter, with a focal length of 180 millimeters, or slightly more than seven inches. It is inserted into a metal cell with an outside thread of 40 turns per inch.

Objective and eyepiece are mounted in an aluminum tube 8½ inches long, whose outside and inside diameters are 2⅜ and 2¹⁄₃₂ inches, respectively. In buying such a tube, ask for aluminum pipe, rather than aluminum tubing. It is strong enough to stand chucking in a lathe when the inside wall is threaded to take the objective and eyepiece. The objective end of the tube should be threaded far enough so the metal cell can reach about ¼ inch inside the tube. Thus, the back surface of the objective is approximately 7⅛ inches from the front surface of the eyepiece. This arrangement provides a focusing range from about 10 feet to infinity. The details of the assembly are seen in the diagram on the next page.

As shown in the photograph, a front-surface aluminized or silvered mirror is mounted at a 45-degree angle in front of the objective. Its purpose is

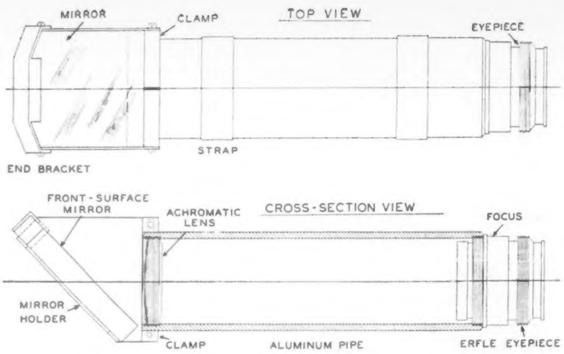
The MOONWATCH telescope is very simple to construct and to use. Compare this view of a sample instrument with the diagram of the optics and parts on the next page of this bulletin.



to allow the observer to watch his sky area in comfort, irrespective of its altitude above the horizon. The mirror need not be of highest optical quality, but it should not introduce undue light loss or distortion. It must be large enough to fill the entire area of the objective. Whatever form of mounting is selected, it is important that the horizontal axis of rotation of the telescope (for change of altitude) lie as close as possible to the center of the 45-degree mirror.

Entirely apart from its use as a MOONWATCH instrument, this monocular is excellent as a small rich-field telescope, and installation of a reticle in the focal plane converts it into a very effective finder.

R. H. DELLAR



The details of the MOONWATCH telescope.

VIII. A Chronograph for Timing Satellite Observations

EDITOR'S NOTE: The article below describes an excellent satellite timing procedure, but relatively expensive timing and recording devices are *not* necessary to do adequate MOONWATCH timing. Teams can do well by using stop watches or simply by having one person call off successive seconds as received by radio. Each observer then mentally estimates satellite passage to a fraction of a second.

One of the most exacting requirements of the MOONWATCH program is accurate timing. The following procedure can allow a precision of 1/10 second in visual observations of an artificial satellite. The time record is made on paper, using a pen-and-ink recording chronograph.

I employed a recording seismograph drum, an instrument which has a pen travel of 60 millimeters per minute. The construction of a simple chronograph is described in *Amateur Telescope Making—Advanced,* page 460. Instead, one could use a Sanborn hot stylus, a Brush oscillograph, a Sprengnether ink recorder VR40-0 or VR40T, or a recording voltmeter or milliammeter. Any one of these recorders draws a time line in which uniformly spaced reference marks can be inserted.

These marks may be provided by a chronometer with contacts that close once a minute, by any good pendulum clock, or by a Sangamo Electric Co. BC-608A surplus contactor unit. This unit costs about \$1.50, and can be adjusted to a rate of within two seconds gain or loss per day.

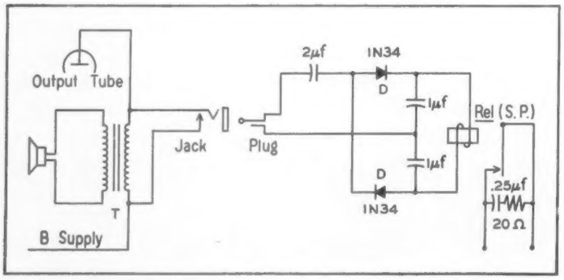
Time indicated by the clock is then checked periodically against accurate short-wave radio time signals broadcast by WWV in the United States or WWVH in Hawaii. For information about these time signals, see *Sky and Telescope,* October, 1956, page 542, or write Radio Standards Division, National Bureau of Standards, Boulder, Colo. The most satisfactory method of comparing radio and clock time is to register the radio time signal directly on the chronograph record; this allows measurement of the clock correction with at least as much accuracy as attained in timing the observations. To do this, a relay must be closed to deflect the recorder pen in response to the make and break of the radio signal.

The diagram shows a rather simple and inexpensive solution of this problem. The audio-frequency voltage across the speaker transformer primary *T* of the radio receiver is rectified in a voltage-doubling circuit containing the two diodes *D*. The output of this system is applied to the coil of a plate-circuit relay *Rel*. With the circuit components listed, the relay closes on about 10 volts. A good time record is given when this relay closes in parallel with the clock contacts, which are connected to a battery or suitable d.c. power supply to deflect the recording pen.

If each observer has a microswitch in parallel with the clock and radio relay, he can deflect the pen to record his time of observation. Afterwards, the time of observation is obtained by measuring the paper record and applying the clock correction.

Many refinements could be added to this basic system. For example, the observer who makes the record can be identified by placing a resistor in series with each microswitch, so there is a predetermined amount of pen deflection from each observing post. It is possible to have observers viewing the northern sky make upward deflections on the record, and downward deflections for observers facing south, by reversing polarity.

WALTER G. MARION
University of California



Matched diodes (Sylvania 1N35) give best results in this chronograph trigger circuit. The relay (Potter and Brumfield PW-5LS) has a coil impedance of 5,000 ohms; any similar plate relay will serve.

visual meteor data published by myself are misused as a basis for certain calculations. The paper deals with the relationship between the masses and the visual magnitudes of meteors. The author refers to some visual train durations derived by Millman and Robins and published in the *Journal* of the Royal Astronomical Society of Canada (*44*, 209, 1950). In the first place these visual data, especially for faint meteors, were qualitative rather than quantitative. The mean train durations are taken by Kallmann, who makes the quite unwarranted assumption that for positive magnitudes the train duration equals the duration of the visual meteor. This invalidates the results. A quick calculation, using the Perseid shower as an example, indicates that this false assumption introduces a discrepancy of 25 to 1 for the faint meteors, and of 1 to 4 in the opposite sense for the bright meteors.

It will be realized from the above remarks that this volume should not be used as a textbook on meteors by the uninitiated. However, for those who want a stimulating survey of some of the current thinking in meteoric astronomy, this is a very useful and worth-while book.

PETER M. MILLMAN
National Research Council
Ottawa, Ontario

THE STARS BY CLOCK AND FIST

Henry M. Neely. The Viking Press, New York, 1956. 192 pages. $4.00.

WHAT I like about this latest book on constellation study is the author's use of standard navigational and astronomical terms while writing so simply that everyone who reads can understand him. This is no small art, as anyone who has attempted writing directions about things in astronomy must know.

Probably no two individuals learn the constellations in the same way. Certain standardized procedures have been developed for group teaching, such as to navigation classes and to scout troops. But there are few good books on constellation study, and the individual reader usually has trouble getting started because he does not understand the apparent motion of the sky.

It is here that Mr. Neely's book is outstanding. His star maps have some drawbacks, but in conjunction with the finding lists the maps tell a person almost without fail what he is looking at up in the sky. There are only 18 pages of actual instructions to study, in large easy-to-read type, lucidly written. The reader learns to divide a clock face into 24 equal parts, the clock being imagined placed horizontally with the observer in the middle of it. The clock is therefore a simple device for specifying azimuth, and the first column of the star lists has each object's direction indicated accordingly.

Then the observer holds his fist approximately at arm's length, in such a way as to make an angle of 10 degrees on the sky. Fists can be added as when choosing sides on a baseball bat, and it should take nine of them to get to the point overhead. Trying this out myself, I was amazed at how accurately the overhead place could be fixed, whereas it is otherwise quite difficult to look up and select the zenith, even if you try it lying on your back. If the observer's fist is too large, he holds his arm out straighter.

Here are typical paragraphs, telling about the hourly lists:

"The Hourly Lists in this book follow the astronomer's clock. List 1 starts with

the positions of the stars at the astronomer's zero hour. For each sidereal hour after that there is a new list, with the positions of all the stars recalculated for their motions during the hour. So there are twenty-four Hourly Lists and after using List 24, we start with List 1 again.

"But, of course, that is time as told by the sidereal clock and not by your watch. So we convert this sidereal time into your clock time, allowing for that 4-minute daily gain, and we simplify the whole problem by means of the easy diagrams—one for each month—beginning on page 42."

The lists have four main divisions: the north sky, the brightest stars, other stars easily found, and the zodiac. There is a finding list for the planets to 1970.

It is strange that Mr. Neely has decided not to use the simple astronomical device of the magnitude scale to describe star brightnesses. Instead, he used these divisions:

Most Brilliant	(MBril)	Bright	(Brt)
Very Brilliant	(VBril)	Medium	(Med)
Brilliant	(Bril)	Ordinary	(Ord)
Very Bright	(VBrt)	Dim	(Dim)

Vega and Arcturus are called very brilliant, while Betelgeuse is brilliant and Deneb is very bright. Denebola (magnitude 2.23) is medium, Mirach (2.37) is only ordinary, and Megrez (3.44), where the handle joins the bowl of the Big Dipper, is dim. What designation can the novice think of for all the other stars in the sky that are dimmer than this, sometimes making up entire constellations? This method of brightness indication should be abandoned by Mr. Neely in his next edition, in favor of the simpler and more versatile numerical scale of magnitudes.

Nearly as undesirable are the varied symbols for the stars on the maps, some large with 8 and 10 points, some with hollow centers, and not one of them having the simple appearance of a star in the sky. The star maps are sometimes confusing, with large lettering overwhelming the constellation patterns, and with Greek letters spelled out. The constellation names, in very large letters, are needlessly enclosed in boxes. There are 60 of these maps, yet they should be revised to enable the beginner not only to find a constellation in the sky but to pick out its stars as well.

To make his charts useful for more than one latitude, Mr. Neely has borrowed a device from *Sky and Telescope's* monthly maps, in which he shows three horizons along the top or bottom of each chart. These are labeled N for an observer at high latitudes (about 50° north), C for about 40° north, and S for about 30° north, and the charts go well above and below these limits. They can be used effectively as far south as Mexico City.

C. A. F.

NEW BOOKS RECEIVED

Dictionary of Photography, *A. L. M. Sowerby*, editor, 1956, *Philosophical Library*. 719 pages. $10.00.

This is the 18th edition, revised and enlarged, of a reference handbook for amateur and professional photographers. While containing much information on photographic equipment, materials, and processes, the manual deals with general rather than such specific applications as astronomical photography.

Antarctica in the International Geophysical Year, 1956, *American Geophysical Union*, 1515 Massachusetts Ave. N.W., Washington 5, D. C. 133 pages. $6.00.

Based on a symposium held in April, 1956, this illustrated book includes 16 papers by authorities on Antarctica and contains much of the latest information which will be useful for members of the International Geophysical Year Antarctica staff. Among the astronomical subjects are geomagnetic disturbances, clues to ionospheric conditions in the southern auroral zone, and the aurora australis and related phenomena. An envelope in the inside back cover has a large, 42-by-42-inch map of Antarctica.

Robert Hooke, *Margaret 'Espinasse*, 1956, *University of California Press*. 192 pages. $3.75.

In this biographical sketch, Hooke's many contributions to navigational and astronomical instruments are noted. He is credited with being the first to observe the rotation of Jupiter. A rival of Isaac Newton, Hooke is also famed as a physicist and microscopist.

A Classification Catalog of the Meteoritic Falls of the World, *Frederick C. Leonard*, 1956, *University of California Press*. 79 pages. $1.75, paper bound.

More than 1,500 meteoritic falls are listed, each with its geographical location, and with the classification of the meteorite material on Professor Leonard's revised system. When known, the weight of matter recovered and the date of fall or of discovery is given.

The World We Live In, *Life Magazine* and *Lincoln Barnett*, 1956, *Simon and Schuster*. 216 pages. $4.95.

Originally published in *Life*, this brilliantly illustrated edition has been adapted for young readers by Jane Werner Watson. A chapter is devoted to astronomical pictures, including fanciful drawings of the landscapes of Mercury and Mars.

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A $75 Value for Only $7.50

Made of sturdy steel and brass — weight 5 pounds. Length 22½". 12° 19' field!

Another fine quality instrument throughout — produced by America's leading optical manufacturers. Telescope consists of a Kellner eyepiece, reticle, 2 achromatic erector lenses, 1 achromatic objective lens (25-mm. diam.), and a protective window. All optics are low-reflection coated. Also included: a rubber eyeguard, and amber, red, and neutral filters for snapping on to eyepiece. All these telescopes equipped with small window through which reticle can be illuminated with small flashlight.

By removing 3 screws, you can separate scope into 2 pieces, one of which makes an excellent 6-power finder for an astronomical telescope on which reticle can be illuminated for night use. To give you some idea of the intrinsic value you are getting here — as surplus, the lenses alone would cost double the price we are asking for the entire instrument. Bear in mind, too, that the eyepiece by itself can be used for an astronomical telescope.

Stock #80,055-Y Completely boxed with protective absorbent, exactly as received from Army (new or near new) $7.50 ppd.

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The mounting rings from our standard 7-power finder can be used on the above M-70 telescope.

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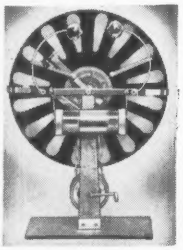

See a thrilling spark display as you set off a miniature bolt of lightning. Yes — here is an ingenious, new educational toy that will excite young and old alike. Absolutely safe and harmless. Scientifically known as Wimshurst static machine. Now for the first time you can own such a machine at our amazingly low price. Sturdily made — stands 14" high. Turn the handle and two 9" plastic discs rotate in opposite directions. Metal collector brushes pick up the static electricity, store it in the Leyden-jar-type condenser until discharged by the jumping spark. You can light electric gas glow bulbs right in your own hand. Countless other tricks and experiments — or test your own original electronic idea. Included with machine you get discharger, 2 luminous plates, jingle bell, dancing balls, 2 electric whirls and 24-page instruction booklet. Your money back if not delighted.

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Rack and pinion, micrometer-smooth focusing with tension adjustment. Two-piece rigid diagonal construction. All-aluminum black anodized tube. No-distortion adjustable mirror mount, easily removed for mirror cleaning. Tube ventilated. Real equatorial mount — one smooth motion follows stars, planets. Sturdy hardwood tripod. Counterweight for perfect balance. Shipping weight approximately 25 lbs.

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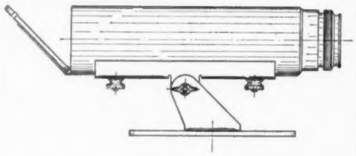

Power 5½X, Field of View 12°

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Complete Scope with Mount

Has six-element war-surplus Erfle eyepiece, 51-mm. diam. coated objective achromat, first surface, over-coated mirror for easy observing. Mount included but is improved type differing slightly from illustration above.

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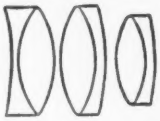
Optical Parts for Those Desiring to Make Their Own Satellite Scope

Stock No.		Price, ppd.
5160-Y	1¼" F.L. Erfle mounted eyepiece	$12.50
6231-Y	Achromatic objective lens, 51-mm. diam., 180-mm. F.L.	2.75
6344-Y	Same objective as above but coated	3.75
30,209-Y	First surface mirror	2.00

MOUNTED ERFLE EYEPIECE

68° FIELD OF VIEW



Consists of 3 coated achromats in metal mount with spiral focusing. F.L. 1¼". Diam. 54 mm., length 54 mm. War surplus. Govt. cost about $84.00. This is the type war-surplus bargain that will be talked about in years to come. Buy while you can.

Stock #5160-Y, $12.50 ppd.

ERFLE ADAPTER

Provides 1¼" diameter mount for fitting above Erfle eyepiece into standard eyepiece holders.

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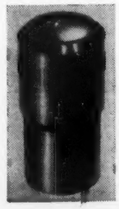
1¼" diam.

WAR SURPLUS TELESCOPE EYEPIECE



Mounted Kellner Eyepiece, Type 3. 2 achromats, F.L. 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for all types of telescopes. Govt. cost $26.50.

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GLEANINGS FOR ATM's

CONDUCTED BY ROBERT E. COX

THE CUSTER 12½-INCH SPRINGFIELD REFLECTOR — I

MANY an amateur telescope maker builds several instruments before making his ideal telescope, the "pet" he chooses for serious observing work and in which he takes greatest pride. Clarence P. Custer, a physician and surgeon in Stockton, California, has built only two instruments, however, a 6-inch prize-winning reflector (*Sky and Telescope*, January, 1952, page 66) and a 12½-inch on a revised Porter Springfield mounting.

It is the latter telescope for which we shall describe the design and workmanship, beginning this month, in the hope that other amateurs who are contemplating the Springfield type for a large, permanently mounted instrument may profit by Dr. Custer's experiences.

The photograph of the complete telescope (Fig. 1) shows the high pier that was necessary to allow the tube to clear the ground. This cork-lined tube is 16 inches in diameter and 10 feet long, of 20-gauge rolled iron. The pier, embedded in five cubic yards of concrete, has a ⅜-inch wall thickness and is filled with concrete to add mass and rigidity. Although the small counterweight (upper right of picture) weighs only 65 pounds, an additional 150 pounds of lead is concealed in the narrow end of the cone of the counterweight arm to complete the balancing of the telescope. The cone is fastened to a curved sheet of boiler iron that covers the entire end of the inside of the tube, being welded to it for greater strength. No flexure of this assembly has been detected in operation.

An electrical conduit runs through the center of the cement-filled pier and ex-

Fig. 1. This picture shows the telescope as it was originally completed several years ago, with Dr. Custer standing alongside. He has since made many modifications for prime-focus photography.

Fig. 2. The mirror cell support.

tends underground to a master switch in his garage at the left. The large hole near the lower end of the tube gives access to the mirror, not only for cleaning it in place but also for the insertion of a rubber cover with a rim vulcanized around its edge to protect the mirror from dust and water. The cover is rolled up sufficiently to permit insertion through the hole and the rim around its edge fits over the mirror cell.

The observing chair is conveniently adjusted, for it can be quickly moved up or down the angle-iron tracks to any set of supporting holes, where it is held on pegs bent upwards at a right angle. The seat and back are adjustable for height and distance from the pier. Ascent and descent are made by means of a stepladder.

The right-ascension assembly is provided with a slip ring, so finding objects is easy; for example, one evening in an hour's time 17 objects were shown to a few friends with an average of only about one minute between settings of the instrument.

Dr. Custer invested 145 hours of working time on the $12\frac{1}{2}$-inch mirror, over a period of 130 days. The mirror is mounted on a three-point support surrounded by a screen-covered outer cell that provides ample ventilation, permitting the mirror to come to equilibrium with the air temperature very rapidly. The strong metal ring (Fig. 2), at the top of the mirror

Fig. 3. Another view of the uncoated mirror in its cell.

Robert E. Cox to Conduct Gleanings Department

With this issue, your former Gleanings editor turns over his responsibilities to Robert E. Cox, of the Boston University Optical Laboratory. For the past several years as business commitments increased, I have had less and less time to devote to the department, while Mr. Cox has carried on much of the Gleanings correspondence.

Since long before the Gleanings department began in the *Sky* some 17 years ago, I have known Mr. Cox, along with others of the original New York telescope making group: Louis Lojas, who now has his own optical plant in White Plains, N. Y.; Edward Hanna, an optical technician at the Perkin-Elmer Corporation; Richard S. Luce, who has been for many years leader of the telescope making group at the Hayden Planetarium; and several more.

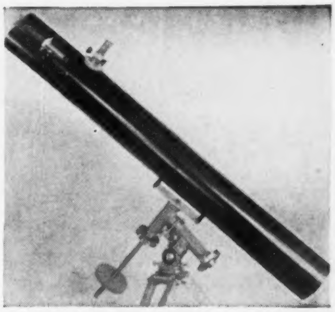
No doubt Mr. Cox will feel well rewarded, as I have, by the interest shown by the readers and contributors of Gleanings, for your participation has been essential to carrying out the aims of this part of *Sky and Telescope*.

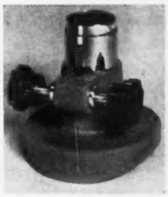
EARLE B. BROWN

EDITOR'S NOTE: A New Englander by birth, Mr. Brown took up accounting in Boston and moved to New York in 1935, soon joining the Optical Division of the Amateur Astronomers Association. Although he obtained his certified public accountant's license in 1938, his interest in optics and astronomy led him to study mathematics and allied subjects at New York University, and in 1941 he became general manager of the revived optical firm of Wm. Mogey and Sons. He was inducted into the army in 1942, just after being married. He was assigned to the Ordnance Department, thence to the instrument repair shop at Aberdeen Proving Ground. As an instructor in optics, he wrote a book, *Optical Instruments*, which appeared in 1945.

In the postwar years, Mr. Brown became a consultant in optical coatings, finally joining the staff of Farrand Optical Co. in 1947, where he is today, having been made chief project engineer in 1951. His work is principally supervision and system planning on optical, mechanical, and electronic equipment for the military.

From 1938 to 1942, Earle Brown taught astronomy classes for the New York society, and in 1948 he wrote a second book, *Basic Optics for the Sportsman*. His Gleanings series of "Notes on Basic Optics" was completed in the September *Sky and Telescope*, having run every other month since May, 1953. It is expected that the notes will be reprinted under one cover in the near future.





holder, bolts onto the outside of the telescope tube. Below this ring is a slit through which a cardboard cover can be inserted to protect the mirror surface from falling objects while adjustments are being made inside the upper end of the tube, such as on the diagonal or prime-focus camera. The hasps at the left and right are for padlocking the cell to the tube.

The sides of the cell holder are cut away to allow good circulation of air. The screening was originally placed there to prevent damage to the mirror from small boys throwing rocks or from their probing with instruments such as screwdrivers. In Fig. 3, the cell is seen through the uncoated mirror. The small flat ring and its three supports are a part of the cell pattern—bottom and sides of the cell are from 3/16-inch boiler plate; the openings were cut out (with a torch) to aid further in temperature stabilization as well as to lighten the weight. A triangular support above this ring holds three pads at the 70-per-cent zone of the radius of the mirror, distributing the weight evenly between the area inside the pads and that outside of them.

Three bolts are fastened on the bottom of the triangular plate and extend down through the lower supporting system. Strong springs, located between these surfaces, supply the tension for the adjusting nuts beneath the lower ring.

Light from the primary mirror is reflected to the large aluminized diagonal, shown with its support in Fig. 4. This diagonal sends the light down the declination axis to the prism in the Springfield equatorial head; the prism turns the light again so it enters the eyepiece that is located over the polar-axis bearing. The oddly cornered diagonal and the support shown in Fig. 4 have been replaced, since that picture was taken, by a more conventional elliptical flat and a spider with four band-saw legs, on two different levels, so constructed that the legs can be maintained under high tension and will "sing" at high A when plucked. Misalignment occurred from flexure of the base of the single-ring support on the tube, when the latter was turned in various positions. The new support's resistance to flexure far outweighs the advantages of uniform diffraction scattering by the single-ring support. At the flat itself, the adjusting knobs permit accurate aligning and centering of the optical elements.

Fig. 4. The original single-ring type of diagonal support assembly is here seen resting on a work table.

The heart of the Springfield design is the equatorial head, bolted to the top of the pillar (Fig. 1). The castings were made in Toledo, Ohio, by E. S. Ensign and machined in Stockton at the Carando Machine Works. With a telescope twice the diameter of the original Porter design and weighing 350 pounds, the scaled-up mounting may be somewhat overloaded mechanically, but it has been in constant operation since 1949 and has shown no evidence of stress or strain. As we shall see next month, when we illustrate the internal parts of the mounting head, careful attention has been given to every technical and mechanical detail, resulting in satisfactory observing performance.

(To be continued)

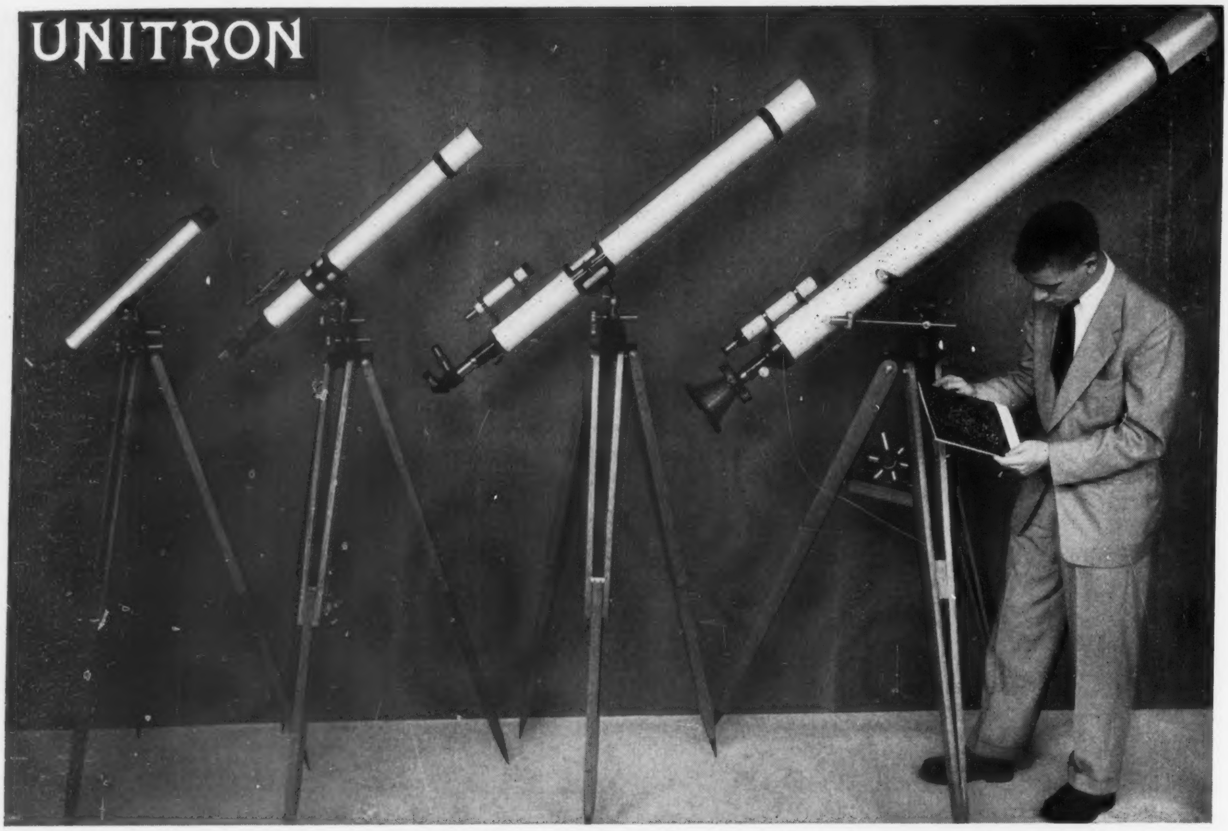
FIGURING A PARABOLIC MIRROR BY THERMAL DEFORMATION

As is well known, during a clear night falling temperature causes a parabolic telescope mirror to become slightly overcorrected. André Couder, of the Paris Observatory, noted that this condition can be cured by gentle localized heating of the mirror. This suggested to him the possibility of deforming a spherical mirror before figuring, so that the action of the tool would lead directly to a paraboloid.

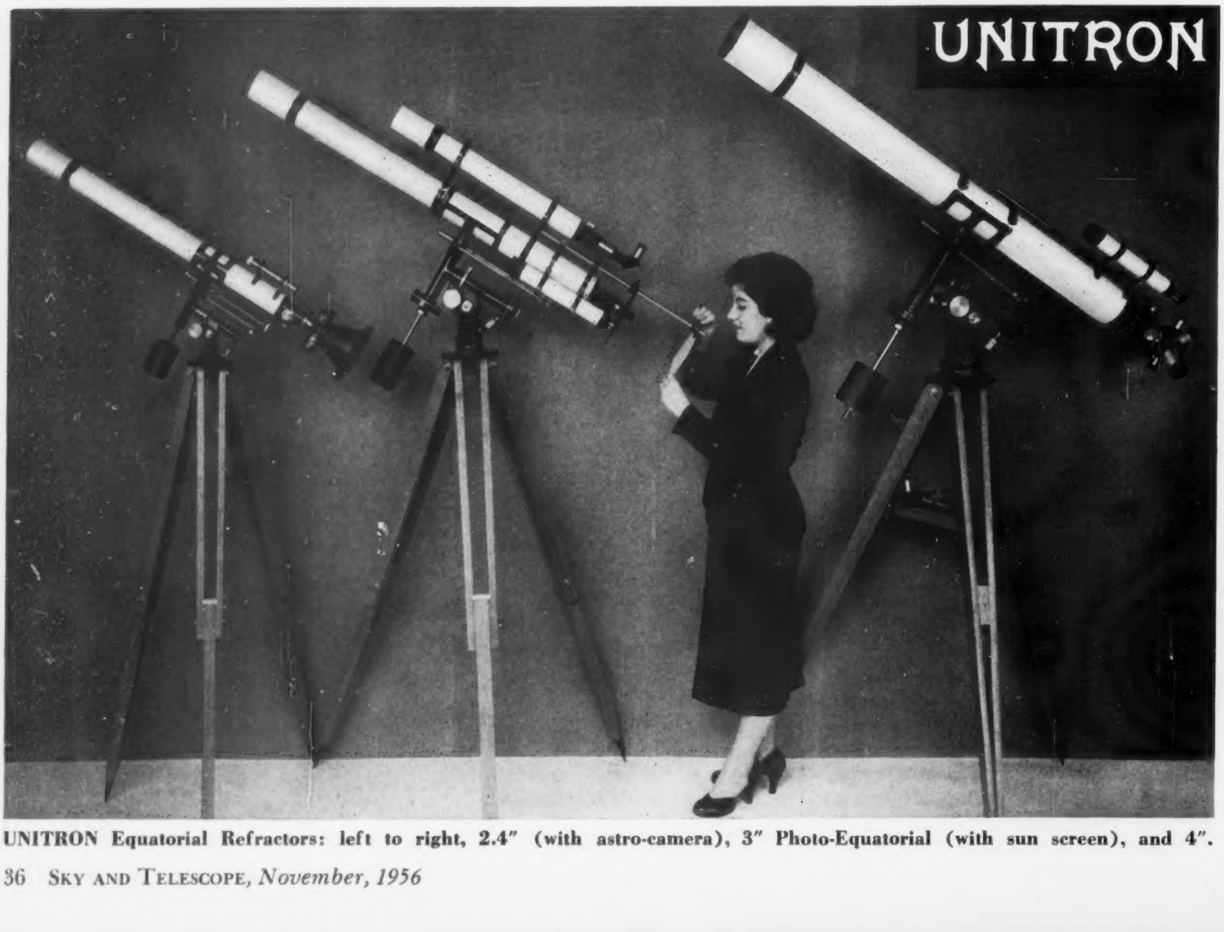
Couder described the successful use of this idea in *Comptes Rendus de l'Academie des Sciences, 235,* 491, 1952. Since this publication is not accessible to many amateur telescope makers, Kelvin Masson, St. Louis, Mo., has forwarded a translation by Allen Strickler, of Fullerton, Calif., from which the following abstract has been made.

The method was used at Paris to figure a 47-inch, f/6 mirror for the Haute Provence Observatory. At the commencement of the work the mirror was nearly spherical, according to the Foucault test. The mirror was then heated in such a way that the deformation of its surface was equal but opposite to the correction desired. One resistance heater, of 28.7 watts, covered a zone at the back of the mirror whose inside and outside radii were 18.5″ and 22.8″. A second heater, dissipating 12.0 watts, was wound along a groove cut in the edge of the disk at the middle of its 7.1″ thickness. Heating was begun about one hour before starting work, during the pressing of the tool.

Figuring lasted about four hours. Tests following the first three stages of polishing showed ellipsoidal shapes of increasing eccentricity, with a tendency toward the formation of a central depression which Couder counteracted by trimming down the central portion of the tool. The fourth test showed that the surface deviated from a true paraboloid by only 1/6 fringe, the extreme edge being slightly raised. When Couder figured an identical mirror by classical methods in 1931, he needed 28 figuring steps to obtain the same results.



UNITRON Altazimuth Refractors: left to right, 1.6″ (with star diagonal), 2.4″ (with erecting prism system), 3″ (with DUETRON double eyepiece), and 4″ (with astro-camera and with UNIHEX on the shelf).



UNITRON Equatorial Refractors: left to right, 2.4″ (with astro-camera), 3″ Photo-Equatorial (with sun screen), and 4″.

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

Program Notes for the Lunar Eclipse

Only one of 1956's four eclipses is visible in North America, but it is a total eclipse of the moon on the night of November 17-18 that will take place under unusually advantageous circumstances for the Western Hemisphere. Throughout our continent, and over nearly all of South America, the entire course of the eclipse will be observable, from the first entry of the moon into the earth's outer shadow or penumbra, through the partial and total phases up to the final emergence of the moon from the penumbra.

The schedule of the eclipse is given here in Eastern standard time, from the predictions in the *American Ephemeris.* To convert to CST (Central standard time) subtract one hour, to MST two hours, to PST three hours.

Moon enters penumbra	10:59.9 p.m.
Moon enters umbra	12:02.6 a.m.
Total eclipse begins	1:08.0 a.m.
Middle of eclipse	1:47.6 a.m.
Total eclipse ends	2:27.3 a.m.
Moon leaves umbra	3:32.7 a.m.
Moon leaves penumbra	4:35.3 a.m.

As a spectacle, this eclipse will be well worth watching, but it is also possible to make useful observations with simple means. A photographic record is easy to obtain, and detailed recommendations for this are given by Peter Leavens in his article on page 43. The unaided eye will serve for many observations of the eclipse, and binoculars add much to the view. A small telescope, 2- or 3-inch, is very effective; with any telescope, the lowest-power eyepiece is generally recommended.

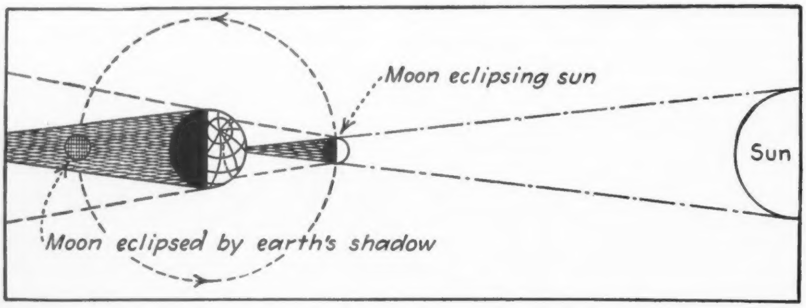
The earth's penumbra is the outer part of its shadow. Within it, to an observer on the moon, the sun would appear only partly eclipsed by the earth. The penumbra surrounds the much darker umbral shadow, the region within which the sun is wholly blocked out for a lunar observer. Since the density of the penumbra diminishes outward from its inner boundary, the entry of the moon into the penumbra is not observable. Perhaps half an hour later a faint dusky penumbral darkening of the eastern edge of the moon may be detectable.

With the first entrance of the moon into the umbra, the eclipse proper begins, and from this point on the changes are marked and rapid. On the Atlantic Coast, this event occurs shortly after midnight, whereas on the West Coast it is just 9 p.m. on Saturday evening, a time convenient for star parties at which the public might be invited to observe. As the eclipse progresses, the obscured portion of the moon is dimly illuminated by sunlight that has been refracted and scattered into the umbra by the earth's atmosphere. The color of this light is quite variable from one eclipse to another; descriptions of it have ranged through orange, copper-hued, and blood red to smoky gray, slate, and black.

The central portion of the umbral shadow is much darker than its outer parts, and thus the eclipsed moon's color may change during the total phase. At different eclipses, the density of the umbra can differ strikingly. Some eclipses are so "light" that during totality the seas and craters remain very distinctly seen, while there are other cases in which the shadow is so dark that the moon entirely disappears from view, as happened in 1816. Occasionally, abnormal appearances have been reported, such as an eccentrically placed dark umbral core, or zigzags in the outline of the earth's shadow.

The following suggestions are offered to amateurs who wish to make systematic observations of this eclipse. The easier projects are listed first.

1. **Colors.** Careful description of the colors on the eclipsed moon can be made at intervals, with the time of each observation recorded. It will be of interest to compare the impressions of observers using the naked eye, binoculars, and telescopes of various sizes.



A fortnight after the November 18th passage of the full moon through the earth's shadow, the new moon will partially eclipse the sun, on December 2nd, for observers in the Eastern Hemisphere.

Three stages in the opening half of the lunar eclipse of September 25-26, 1950, photographed by Indiana University students with the 12-inch Kirkwood refractor. The right-hand picture was made 19 minutes before totality.

2. **Visibility of Moon's Surface.** The darkness of the eclipse can be estimated numerically on Willard J. Fisher's scale: *2*, lunar seas and principal craters easily recognized in binoculars or finders; *1*, a telescope of 2- or 3-inch aperture is needed to show the seas and craters; *0*, a 6-inch telescope or larger is required. It is well to record familiar individual craters as visible or not, and to ascertain whether the whole outline of the moon's disk can be traced during totality. Such data are useful in comparing different eclipses.

3. **Penumbra.** When are the first and last times at which any penumbral darkening of the moon can be detected? During the partial phases, estimate how wide the visible penumbral border is in terms of the apparent diameter of the moon (32 minutes of arc during the eclipse). Previous data of these types are scanty.

4. **Enlargement of the Umbra.** It is well known that the umbra is always slightly larger than the geometry of the eclipse calls for, and lunar eclipse predictions make approximate allowance for this effect. The amount of the enlargement is not the same at all eclipses, for reasons not fully understood. It can be evaluated from carefully observed times of the four contacts of the eclipse.

The enlargement can also be deduced from crater observations during partial phases. Usually the border of the umbra is definite enough so the times of entrance and exit of specific craters into the shadow can be noted. A 3-inch refractor or 6-inch reflector, with a power of about 50, is

ordinarily best for this. For larger craters, note when the shadow first reaches a crater and when the crater is just covered; the average of these times tells when the crater is bisected by the shadow. Record times to 0.1 minute, with the correction of the timekeeping device known to this accuracy. The writer will analyze any such timings reported to *Sky and Telescope.*

5. **Brightness of the Eclipsed Moon.** Usually the totally eclipsed moon is between magnitude −4 and −1, that is, its light may equal that of Venus or be as little as that of Canopus. Eclipse brightnesses can be determined roughly by amateurs experienced in visual observations of variable stars. Some persons are nearsighted enough that by removing their glasses they see the planets and bright stars as large disks, and therefore can directly compare these objects with the eclipsed moon. The advanced amateur can compare with the stars the diminished image of the moon reflected from a silvered Christmas-tree ball, viewed from various distances. This arrangement can be calibrated by observations of the moon before or after eclipse.

Serious observers who do carefully planned work under any of these headings during the November 17-18 lunar eclipse are invited to send reports to *Sky and Telescope,* Harvard College Observatory, Cambridge 38, Mass., for later analysis and inclusion in a comprehensive summary. The report should clearly state the time and optical means used for each observation in the record, and should include details of changing sky conditions.

J. A.

COMET OLBERS OBSERVED

My observations of Comet Olbers (1956a) show that it later became appreciably brighter than magnitude 7 on June 30th as recorded by Dr. G. Van Biesbroeck (see page 518 of the September issue). The following magnitudes were estimated in terms of stars in the Skalnate Pleso *Atlas of the Heavens,* with the aid of 7 x 50 binoculars:

July **28,** comet about magnitude 8; **29,** 6 to 7; **30,** 5.5 to 6.0, looks misty, comparable to the globular cluster M4, tail about ⅛° long; August **2,** 5 to 6; **7,** about 8.0; **8,** about 7.5, diameter ⅛°; **10,** 8.0; **12,** about 8, dimly seen. I am a member of the Astronomical Society of Harrisburg.

ANDREW KEEFER, JR.
Roberts Valley Rd.
Harrisburg, Pa.

MINIMA OF ALGOL

November 3, 6:31; 6, 3:20; 9, 0:09; 11, 20:58; 14, 17:46; 17, 14:35; 20, 11:24; 23, 8:13; 26, 5:02; 29, 1:51. December 1, 22:40; 4, 19:29; 7, 16:18; 10, 13:07.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

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Each lens is thoroughly tested by us and is guaranteed to resolve two seconds of arc or better. They are corrected for the C and F lines (secondary chromatic aberration). The zonal spherical aberration and the chromatic variation of spherical aberration are negligible. The cell is machined to close tolerances so that it will fit directly over our standard aluminum tubing, eliminating any mounting problems.

3¼" diam., 48" f.l. (uncoated) .. **$28.00**
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Diameter	Focal Length	Each	Diameter	Focal Length	Each
54 mm (2⅛")	254 mm (10")	$12.50	83 mm (3¼")	660 mm (26")	$28.00
54 mm (2⅛")	300 mm (11.8")	12.50	83 mm (3¼")	711 mm (28")	28.00
54 mm (2⅛")	330 mm (13")	12.50	83 mm (3¼")	762 mm (30")	28.00
54 mm (2⅛")	390 mm (15.4")	9.75	83 mm (3¼")	876 mm (34½")	28.00
54 mm (2⅛")	508 mm (20")	12.50	83 mm (3¼")	1016 mm (40")	30.00
54 mm (2⅛")	600 mm (23½")	12.50	102 mm (4")	876 mm (34½")	60.00
54 mm (2⅛")	762 mm (30")	12.50	108 mm (4¼")	914 mm (36")	60.00
54 mm (2⅛")	1016 mm (40")	12.50	110 mm (4⅜")*	1069 mm (42 1/16")	60.00
54 mm (2⅛")	1270 mm (50")	12.50	110 mm (4⅜")	1069 mm (42 1/16")	67.00
78 mm (3 1/16")	381 mm (15")	21.00	128 mm (5 1/16")*	628 mm (24¾")	75.00
80 mm (3⅛")	495 mm (19½")	28.00	128 mm (5 1/16")	628 mm (24¾")	85.00
81 mm (3 3/16")	622 mm (24½")	22.50	*Not coated		

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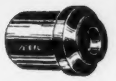
MOUNTED EYEPIECES



The buy of a lifetime at a great saving. Perfect war-surplus lenses set in black anodized standard aluminum 1¼" O.D. mounts.

F.L.	TYPE	PRICE
12.5 mm (½")	Symmetrical	$ 6.00
16 mm (⅝")	Erfle (wide angle)	12.50
16 mm (⅝")	Triplet	12.50
18 mm (¾")	Symmetrical	6.00
22 mm (27/32")	Kellner	6.00
32 mm (1¼")	Orthoscopic	12.50
35 mm (1⅜")	Symmetrical	8.00
55 mm (2 3/16")	Kellner	6.00

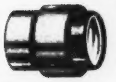
COATED 75 cents extra.

ASTRONOMICAL MIRRORS

These mirrors are of the highest quality, polished to ¼-wave accuracy. They are aluminized, and have a silicon monoxide protective coating. You will be pleased with their performance.

	Diam.	F.L.	Postpaid
Plate Glass	3 3/16"	42"	$ 9.75
Pyrex	4¼"	45"	$13.50
Pyrex	6"	60"	$25.00

AN ECONOMICAL EYEPIECE



This mounted eyepiece has two magnesium-fluoride coated lenses 29 mm in diameter. It is designed to give good eye relief. It has an effective focal length of 1¼" (8x).

The eyepiece cell fits a 1¼" tube........ **$4.50**

Aluminum Telescope Tubing

O.D.	I.D.	Price Per Ft.
2¼"	2⅛"	$1.20
3⅜"	3¼"	1.75
4½"	4⅜"	2.75
5"	4⅞"	2.75

All tubing is shipped POSTPAID.

Focusing Eyepiece Mounts Rack & Pinion Type

The aluminum body casting is finished in black crackle paint and is machined to fit all our aluminum tubing. Has a chrome-plated brass focusing tube, which accommodates standard 1¼" eyepieces.

For 2⅛" I.D. Tubing	Postpaid	$12.95
For 3¼" I.D. Tubing	"	12.95
For 4⅜" I.D. Tubing	"	12.95

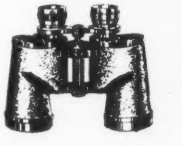
Reflector type for all size tubing.

Complete with diagonal holder....... **$ 9.95**

Aluminum Lens Cells Black Anodized

Cell for Lenses	Cell Fits Tubing	Price
54 mm Diam.	2⅛" I.D.	$ 3.50
78 mm "	3¼" "	6.50
81 mm "	3¼" "	6.50
83 mm "	3¼" "	6.50
110 mm "	4⅜" "	10.50

COATED BINOCULARS



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SIZE	TYPE	C. FOCUS	IND. FOCUS
6 x 15	OPERA	—	$12.75
6 x 30	ZEISS	$18.75	16.75
7 x 35	ZEISS	21.25	19.25
7 x 35	AMERICAN	23.50	—
7 x 35	AMERICAN WIDE ANGLE 10°	37.50	—
7 x 50	ZEISS	24.95	22.50
7 x 50	AMERICAN	32.50	—
8 x 30	ZEISS	21.00	18.25
10 x 50	ZEISS	30.75	28.50
20 x 50	ZEISS	41.50	39.50

MONOCULARS

Brand new, coated optics, complete with pigskin case and neck straps.

	Price		Price
6 x 30	$10.00	7 x 50	$15.00
8 x 30	11.25	16 x 50	17.50
7 x 35	12.50	20 x 50	20.00

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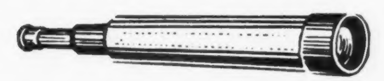

40 power Special Price **$57.50**

Never before has anything like this been offered at so low a price. Here is another example of American ingenuity. Big 3" diameter achromatic coated objective which will give needle sharp crystal-clear images. Focusing is a delight with the micrometer spiral focusing drawtube. Light-weight aluminum construction throughout, black crackle finish, length open 22 inches, closed 17 inches. This telescope gives an upright image—it is WONDERFUL for astronomy, SUPERB for long distances, EXCELLENT as a spotting scope.

"GIANT" EYEPIECE

WIDE ANGLE ERFLE (68° Field) **EYEPIECE.** Brand new coated 1¼" E.F.L. Focusing mount. 3 perfect achromats, 1 13/16" aperture. **$12.50**

WIDE ANGLE ERFLE 1½" E.F.L. Brand new; contains Eastman Kodak's rare-earth glasses; aperture 2"; focusing mounts; 65° field.. **$18.50**

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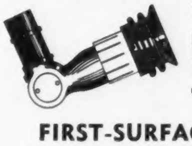

Makes a nice low-priced finder. Brand new; has 1" Achromatic Objective. Amici Prism Erecting System, 1⅜" Achromatic Eye and Field Lens. Small, compact, wt. 2 lbs.

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FIRST-SURFACE MIRRORS

Size	Thickness	Postpaid
14" x 16"	¼"	$10.00
8" x 10"	¼"	4.25
4" x 5"	¼"	1.85
4" x 4"	¼"	1.50
1¼" x 1½"	1/16"	.25

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8 mm face.....ea.	$ .75	28 mm face.....ea.	$1.75
12 mm face.....ea.	.75	38 mm face.....ea.	2.00
23 mm face.....ea.	1.25	47 mm face.....ea.	3.00

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Photographing the Lunar Eclipse

While not as dramatic as a total solar eclipse, the passage of the moon through the long shadow of the earth is nevertheless fascinating both to watch and to photograph. This month's eclipse is the first principal sky spectacle to be seen from the United States since the closing phases of a partial eclipse of the moon along the East Coast in July, 1954.

Owners of telescopes who wish to take photographs must experiment well in advance, practicing on the moon through its succession of phases, which furnish appearances similar to those of an eclipse. The size of the moon's image depends, of course, on the focal length of the telescope, being less than half an inch in diameter for a 6-inch f/8 reflector. Projection of the image through an eyepiece gives a desirable enlargement, but at some loss of sharpness. For the longer exposures required during totality, the telescope should be equipped with a clock drive, but correction to the lunar rate is generally not necessary.

For camera enthusiasts, perhaps the most satisfactory type of eclipse picture is a series on one negative. The camera is set on a tripod, firmly fixed so it cannot be jarred, and the moon's image is placed in one corner of the field for the first exposure. Then, at 10-minute intervals, starting about three minutes before first contact, additional exposures are made. The westward motion of the sky carries the moon's image across the field, so the successive exposures are well spaced and do not interfere with one another.

The schedule here is in Eastern standard time, starting at midnight. The exposures are valid for clear skies at sea level with the moon's altitude above the horizon greater than two hours. The emulsion rating is that of Ansco Isopan, a medium speed, fine-grain, panchromatic film of good contrast, ASA rating 50. It is a sheet film. Ansco Supreme has the same rating, and is a panchromatic roll film. The rating of Eastman Panatomic X is 25, and that of Tri-X is 200, both panchromatic films. The photographer will have to adjust the data given here if he uses films of other ratings than ASA 50.

Exposure No. 1, 12:00 (midnight), f/12.7, 1/50 second. **No. 2,** 12:10, f/11, 1/50 sec. **No. 3,** 12:20, f/8, 1/50 sec. **No. 4,** 12:30, f/8, 1/25 sec. **No. 5,** 12:40, f/6.3, 1/25 sec. **No. 6,** 12:50, f/5.6, 1/25 sec. **No. 7,** 1:00, f/3.5, $\frac{1}{2}$ sec. **No. 8,** 1:10 (total), f/2.8, 1 sec.

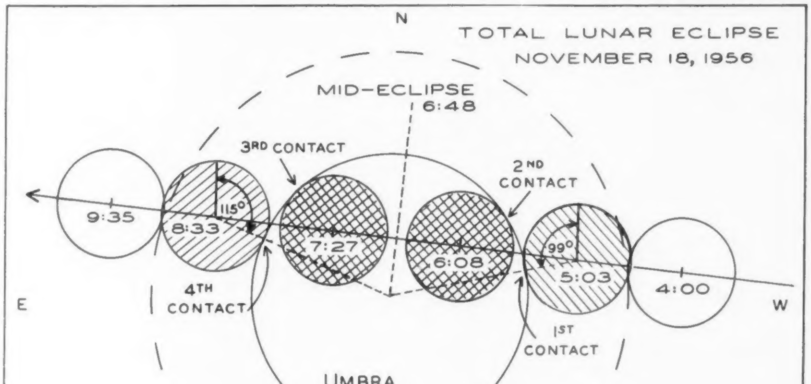
Color pictures are better than those in black and white, as they record the changing hues of the moon's surface. For partial eclipse times corresponding to the black-and-white schedule above, go by the rating of the color film. For instance, Eastman Kodachrome film is ASA 10, while Ektachrome and Anscochrome are 32; thus, with the latter two films the apertures of the black-and-white schedule need be increased only about half a stop. Here is a Kodachrome schedule, again in Eastern standard time:

Moon deep in penumbra, 12:00, f/12.7, 1/10 sec. **Shadow "bite,"** 12:20, f/8, 1/10 sec. **Half immersed,** 12:40, f/6.3, 1/5 sec. **Deep in umbra,** 12:50, f/4.5, $\frac{1}{2}$ sec. **Japanese-lantern effect,** 1:00, f/2.0, 1 sec. **Totality,** 1:10, f/1.4, 1 sec.

An extended series of color shots during total eclipse may give a pleasing exhibit, but the exposures will have to be long enough to record the faint light.

In eastern parts of North and South America, the later partial phases occur close enough to the horizon to permit including foreground scenes or structures in series-type pictures, color or black-and-white. For this, leave the camera in position until just before sunrise, and then make a final exposure, at one diaphragm-stop opening below that indicated by a light meter reading of the brightest portion of the western sky.

Black-and-white moving pictures (lapsed time) should be exposed as follows, for sound speed, Plus-X film: Moon $\frac{1}{4}$ in shadow, f/9; $\frac{1}{2}$ in shadow, f/6.3; $\frac{3}{4}$ in



The moon's positions are labeled in Universal time.

shadow, f/4.5. Try single-frame filming of the moon going into totality, on XXX type, starting with moon 11/12 shaded, at f/1.4. Color movies call for corresponding apertures of f/5, f/3.5, f/2.5, and f/1.4. Telephoto lenses should be used if available. Place the image in the finder before each exposure, compensating for the movement of the sky, and trip the shutter once each second covering a 6-minute scene, or run the camera continuously for the time desired to get a good view when the movie is projected.

Here is an outline of what several photographers might do (or one with the required equipment) during the last half of the eclipse, in Eastern standard time for the morning hours of November 18th:

- 1:50 Shots of totality.
- 2:10 Shots of totality.
- 2:25 Begin lapsed-time motion pictures (one frame per second) of moon emerging from totality. Continue to 2:32.
- 2:32 Begin black-and-white still series picture, exactly every five minutes through 3:27.
- 2:40 Movie continuity, normal speed.
- 2:55 Run six minutes of lapsed-time movies.
- 3:10 Color stills.
- 3:15 Run six minutes of lapsed-time movies.
- 3:22 Movie continuity, normal speed.
- 3:33 Penumbra movie continuity.
- 3:40 Final pictures; movie fadeout.

Amateur photographs of the eclipse, submitted for possible publication in *Sky and Telescope*, should reach the editor not later than Tuesday, November 27th. Only black-and-white prints, at least 4-by-5, are acceptable. The use of air-mail special delivery is suggested for meeting the deadline.

PETER A. LEAVENS
15 Rose St.
Freeport, N. Y.

VARIABLE STAR MAXIMA

November 1, R Corvi, 1214**18**, 7.6; 2, R Andromedae, 001838, 7.0; 2, R Hydrae, 1324**22**, 4.6; 4, S Pictoris, 0508**48**, 8.0; 9, RS Librae, 1518**22**, 7.7; 12, R Virginis, 123307, 6.9; 14, U Ceti, 0228**13**, 7.5; 15, T Hydrae, 0850**08**, 7.7; 20, W Lyrae, 181136, 8.0; 24, X Ophiuchi, 183308, 6.9; 25, R Carinae, 0929**62**, 4.6; 26, R Leonis Minoris, 093934, 7.2; 26, R Sagittarii, 1910**19**, 7.2; 28, R Aquarii, 2338**15**, 7.3; 30, Omicron Ceti, 0214**03**, 3.7.

December 1, T Centauri, 1336**33**, 6.1; 2, R Ophiuchi, 1702**15**, 7.6; 4, R Normae, 1528**49**, 7.2; 7, R Bootis, 143227, 7.3; 10, S Hydrae, 084803, 7.9.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

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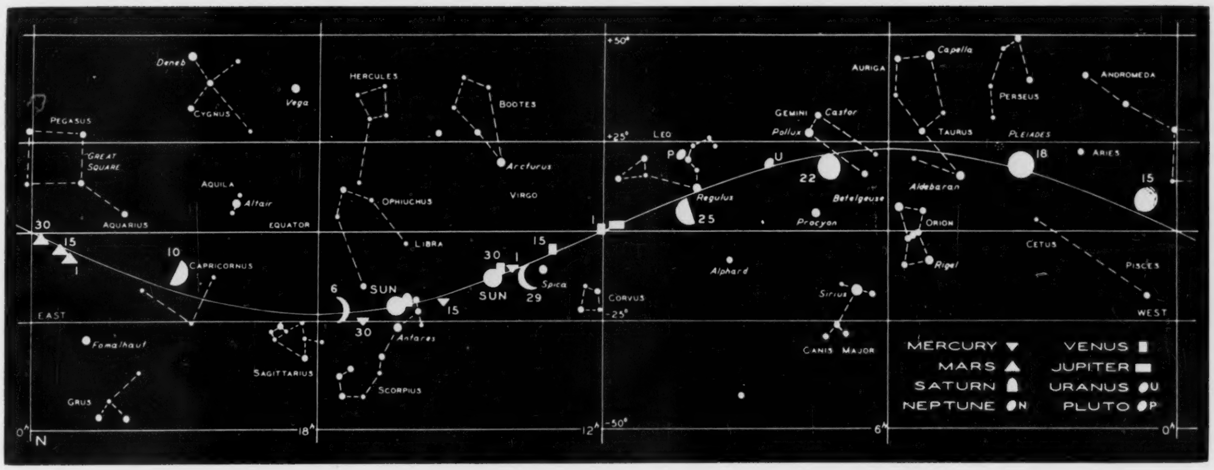


THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown.

Mercury will be in superior conjunction with the sun on November 12th and therefore cannot be observed this month.

Venus continues to move slowly nearer to the sun in the morning sky. The planet rises about three hours before the sun on the 15th, when its magnitude is −3.5 and its 80-per-cent illuminated disk is 13″.6 in diameter. Venus and the moon are in conjunction on the 29th at 17:25 UT.

Mars is now moving eastward at the boundary of Aquarius and Pisces. Though rapidly fading in brightness, Mars is still a good object for a moderate-sized telescope. On the 15th the planet appears on the meridian at about 8 p.m. local time, at a magnitude of −0.8 and with a disk 14″ in diameter.

Jupiter rises five hours before the sun in mid-November and is moving eastward in the sky near Beta Virginis. The magnitude of the planet is −1.4 on the 15th; at this time the equatorial diameter of Jupiter is 33″.3. The planet is in conjunction with the moon on the 27th at 1:06 UT.

Saturn reaches conjunction with the sun on November 27th and cannot be viewed this month.

Uranus may be observed after midnight about 1° south of the Praesepe cluster in Cancer. The planet begins retrograde motion on the 12th and appears almost motionless all month.

Neptune may be seen at the end of November in the morning sky just before twilight begins. On the morning of the 26th at 15:00 UT, Venus will pass only 11′ north of Neptune and will aid in locating this 7.7-magnitude object. At dawn, a pair of field glasses will show Venus less than $\frac{1}{4}$° from its conjunction position, which occurs in midmorning for most of the United States.

E. O.

SUNSPOT NUMBERS

August 1, 133, 140; **2,** 137, 148; **3,** 141, 146; **4,** 141, 149; **5,** 134, 152; **6,** 119, 149; **7,** 122, 151; **8,** 107, 140; **9,** 110, 152; **10,** 102, 165; **11,** 123, 146; **12,** 126, 148; **13,** 122, 150; **14,** 127, 140; **15,** 125, 143; **16,** 137, 143; **17,** 145, 131; **18,** 159, 173; **19,** 192, 192; **20,** 198, 217; **21,** 211, 224; **22,** 217, 237; **23,** 224, 213; **24,** 196, 232; **25,** 170, 154; **26,** 182, 178; **27,** 209, 196; **28,** 175, 198; **29,** 203, 200; **30,** 175, 214; **31,** 164, 182. Means for August, 155.7 American; 171.1 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by Dr. Sarah J. Hill from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

According to Dr. M. Waldmeier's forecast, the smoothed monthly mean sunspot numbers will reach 177 in January, 1957, being practically as high in December and February.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Thyra, 115, 9.3. November 13, 5:22.1 +42-18; 23, 5:13.3 +42-13. December 3, 5:01.6 +41-33; 13, 4:49.4 +40-19; 23, 4:38.9 +38-38. January 2, 4:32.1 +36-44.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

OCCULTATION PREDICTIONS

November 6-7 **21 Sagittarii** 5.0, 18:22.7 −20-34.0, 4, Im: **F** 1:55.7 −0.4 +0.2 51.

November 7-8 **d Sagittarii** 5.0, 19:15.1 −19-02.0, 5, Im: **H** 2:03.7 −2.2 −1.1 97; **I** 1:50.6 −1.3 −0.2 64.

November 19-20 **Zeta Tauri** 3.0, 5:35.0 +21-07.1, 18, Im: **F** 5:36.1 .... 14. Em: **F** 5:58.2 .... 341.

November 19-20 **Chi^1 Orionis** 4.6, 5:51.8 +20-16.2, 18, Em: **I** 14:32.3 −0.3 −1.7 289.

December 15-16 **Omega Tauri** 4.8, 4:14.7 +20-28.3, 14, Im: **F** 10:32.6 −1.0 +1.1 38; **H** 10:09.2 −1.5 +0.7 48.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**LO** − **LoS**), and multiply **b** by the difference in latitude (**L** − **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

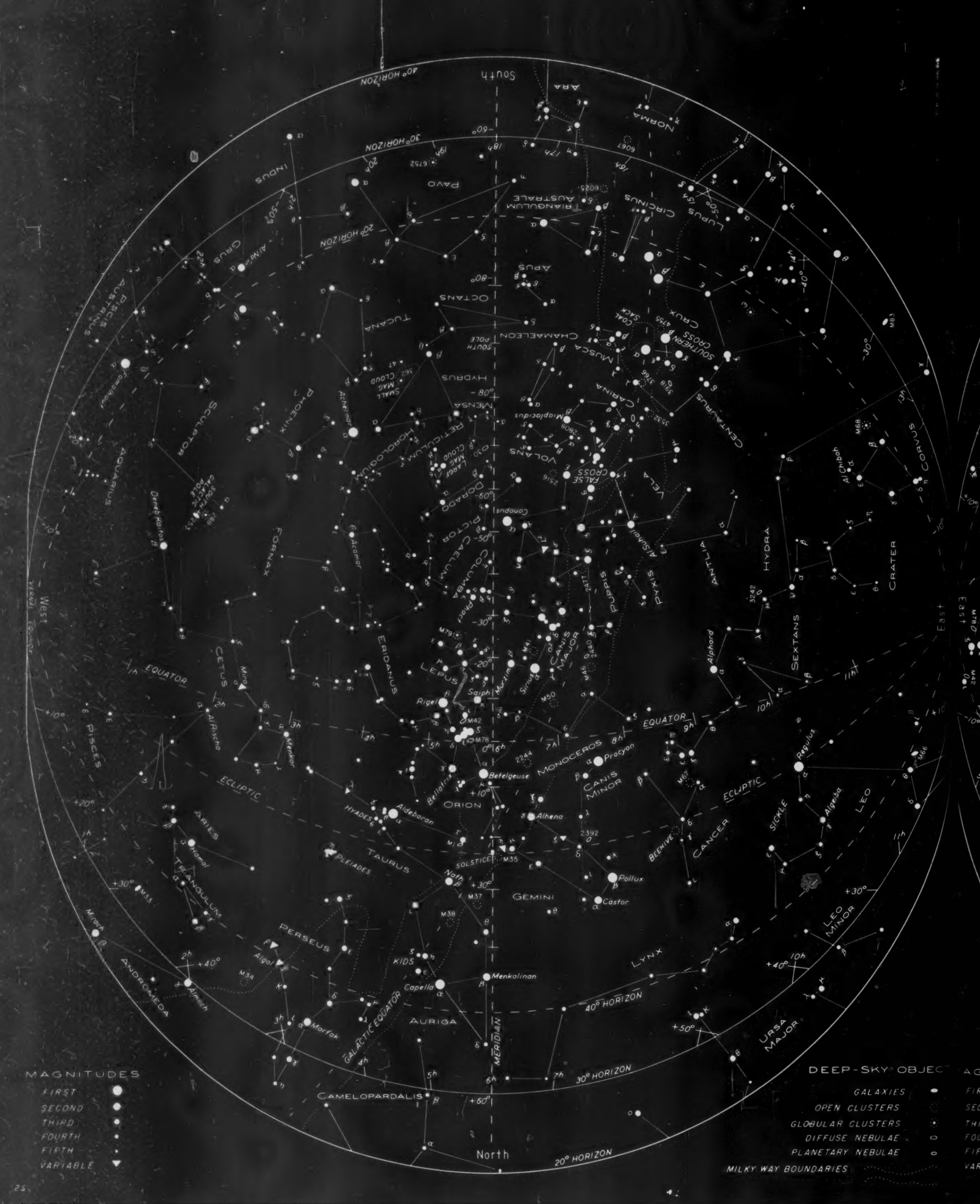
Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

MOON PHASES AND DISTANCE

New moon	November 2, 16:43
First quarter	November 10, 15:09
Full moon	November 18, 6:44
Last quarter	November 25, 1:12
New moon	December 2, 8:12

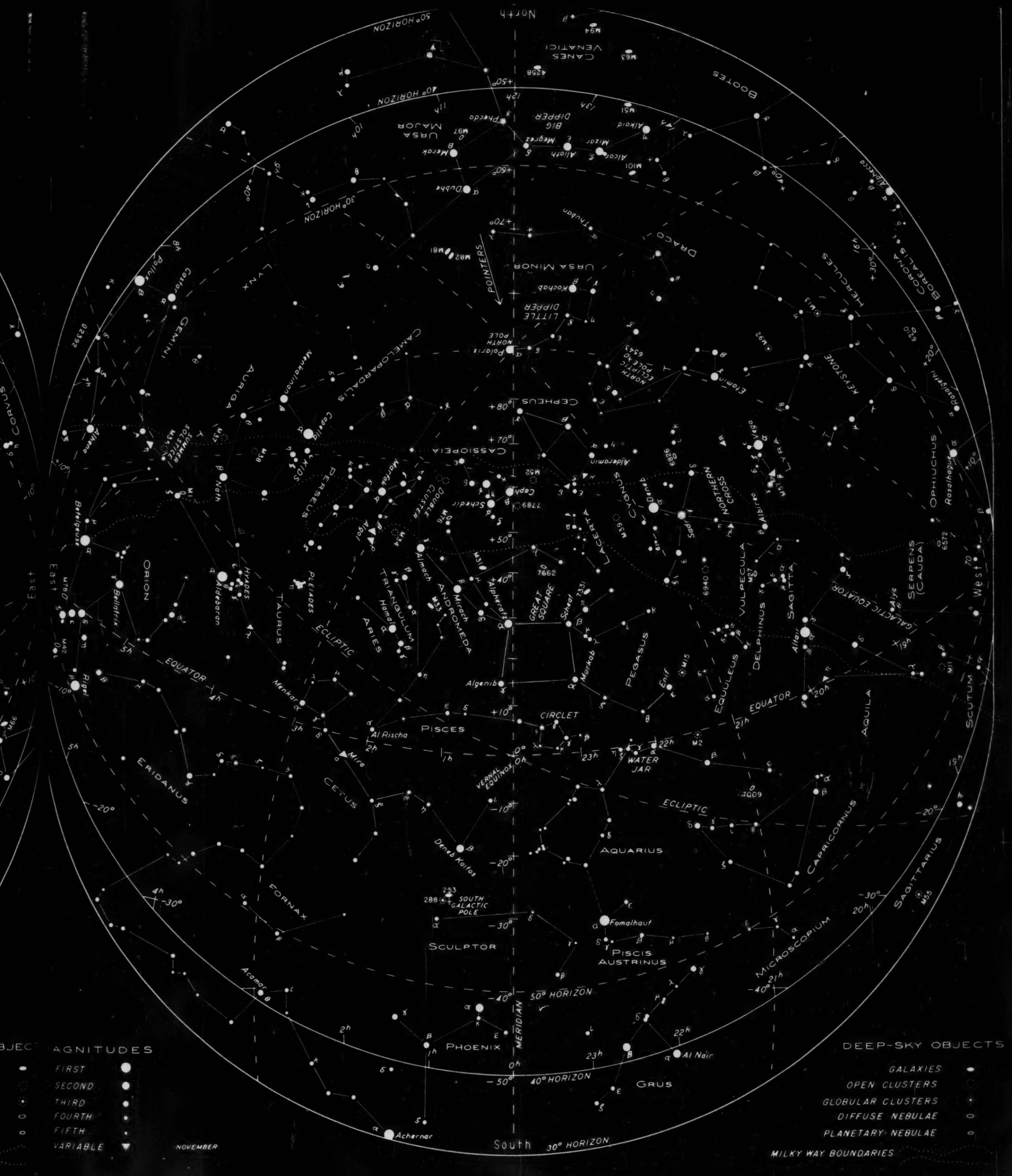
	November	Distance	Diameter
Apogee	9, 19^h	251,300 mi.	29′ 33″
Perigee	21, 17^h	228,000 mi.	32′ 34″
	December		
Apogee	7, 16^h	251,800 mi.	29′ 29″



SOUTHERN STARS

The sky as seen from latitudes 20° to 40° south, at 11 p.m. and 10 p.m., local time, on the 7th and 23rd of January, respectively; also, at 9 p.m. and 8 p.m. on February 7th and 23rd. For other dates, add or subtract ½ hour per week.

Interesting naked-eye objects are the Magellanic Clouds, with the globular cluster 47 Tucanae near the Small Cloud. The Coal Sack appears dark alongside the stars of the Southern Cross. Nearby is the fine open cluster NGC 4755, also known as Kappa Crucis.



STARS FOR NOVEMBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of November, respectively; also, at 7 p.m. and 6 p.m. on December 7th and 23rd. For other dates, add or subtract ½ hour per week.

This is the season when the Great Nebula in Andromeda, a distant counterpart of our own Milky Way system, passes near the zenith for observers in mid-northern latitudes. It is bright enough to be seen with the naked eye from city streets on a clear night.

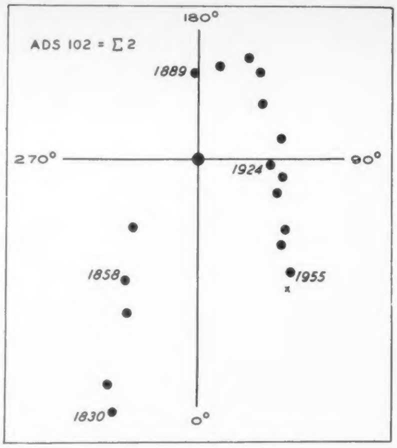
DEEP-SKY WONDERS

WILHELM STRUVE (1793-1864) was the earliest double star observer whose measurements are accurate enough to be used in modern orbit calculations. Sir William Herschel was a great discoverer, but his altazimuth mountings and primitive micrometers could not give the accurate measures needed today, while Struve used equipment that approached modern standards.

Struve's double stars are still called by the numbers he gave them, for instance Σ1 indicates the first star in his list; it is also known as ADS 104, having that number in Aitken's standard *New General Catalogue of Double Stars.* Only one of the first five Struve stars for which data are given here is bright enough to have a Flamsteed number (Σ5 is 34 Piscium), but all except Σ2 can be split with a 6-inch telescope.

Of these first five, four appear "fixed," as the relative position of the components in each case has not changed since discovery. It is now known, however, that the great majority of the apparently fixed double stars are actually long-period binary systems.

When Struve first saw Σ2 with the Dorpat 9-inch refractor in 1828, it was an easy object. Measures on five nights showed that the 6th-magnitude components were 0".81 apart at position angle 341°.5. During the next 30 years the pair



The small dots are observed positions of the fainter star relative to the primary. The cross marks the predicted current position.

Σ	ADS	Position (1950) R.A.	Position (1950) Dec.	Position Angle	Distance Apart	Magnitudes
1	104	$0^h06^m.3$	+36°56′	288°	9".8	8.5 – 10.0
2	102	0 06.3	+79 26	39	0.46	6.3 – 6.6
3	119	0 07.4	+46 07	84	5.0	7.5 – 8.5
4	118	0 07.3	+ 8 11	273	5.2	9.2 – 9.2
5	122	0 07.5	+10 52	161	7.5	6.0 – 10.5

became much closer and more difficult, and in 1869 Otto Struve saw Σ2 as single with the 15-inch Poulkovo refractor. No satisfactory measurements were afterwards made until those of Asaph Hall with the Washington 26-inch telescope, in 1888, when the companion had reappeared on the other side of the primary. Since then the pair has widened very gradually.

This history explains why Struve's second star does not appear in the handbooks of Smyth, Webb, or other writers of the late 19th century; the pair was too close for small instruments. It is now easier. G. Van Biesbroeck's orbit computation in 1954 gives the period as 419 years, and predicts the current position angle and separation as 39°.0 and 0".46, respectively. A good 10-inch telescope should show Σ2 double to an experienced observer when seeing conditions are fine enough to permit very high magnification; under the same circumstances an 8-inch should show an elongated spurious disk. The well-equipped amateur who loves the difficult should try Σ2. It can be easily located on any night of the year not far from Gamma Cephei.

WALTER SCOTT HOUSTON
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